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Environmental Protection Department

Operations and Regulatory Affairs Division

LLNL NESHAPs 2001 Annual Report

Lawrence Livermore National Laboratory
University of California Livermore, California 94551

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Lawrence Livermore National Laboratory NESHAPs 2001 Annual Report

This annual report is prepared pursuant to the National Emission Standards for Hazardous Air Pollutants (NESHAPs; Title 40 Code of Federal Regulations [CFR] Part 61, Subpart H). Subpart H governs radionuclide emissions to air from Department of Energy (DOE) facilities.

SYNOPSIS

NESHAPs limits the emission of radionuclides to the ambient air from DOE facilities to levels resulting in an annual effective dose equivalent (EDE) of 10 mrem (100 μSv) to any member of the public. The EDEs for the Lawrence Livermore National Laboratory (LLNL) site-wide maximally exposed members of the public from operations in 2001 are summarized here.

- Livermore site: 0.017 mrem (0.17 μSv) (34% from point-source emissions, 66% from diffuse-source emissions). The point-source emissions include gaseous tritium modeled as tritiated water vapor as directed by EPA Region IX; the resulting dose is used for compliance purposes.

- Site 300: 0.054 mrem (0.54 μSv) (93% from point-source emissions, 7% from diffuse-source emissions).

The EDEs were calculated using the EPA-approved CAP88-PC air dispersion/dose-assessment model, except for doses for three diffuse sources, which were calculated from measured concentrations and dose coefficients. Site specific meteorological data, stack flow data, and emissions estimates based on radionuclide usage inventory data or continuous stack monitoring data were the specific inputs to CAP88-PC for each modeled source.

SECTION I. Facilities Information

Site Description

LLNL was established in 1952 to conduct nuclear weapons research and development. The Laboratory's mission is dynamic and has been broadened over the years to meet new national needs. LLNL serves as a national resource in science and engineering; its activities focus on global security, energy, global ecology, biomedicine, economic competitiveness, and science and mathematics education. LLNL consists of two sites—the main laboratory site located in Livermore, California (Livermore site), and the Experimental Test Facility (Site 300) located near Tracy, California. Figure 1 shows the locations of the sites. The University of California operates LLNL for DOE.

Livermore Site

LLNL's Livermore site occupies an area of 3.3 km^2 located about 60 km east of San Francisco, California, adjacent to the City of Livermore in the eastern part of Alameda County. In round numbers, 7 million people live within 80 km of the Livermore site; 75,200 of them live in the City of Livermore.

The Livermore site is located in the southeastern portion of the Livermore Valley, a topographical and structural depression oriented east-west within the Diablo Range of the California Coast Range Province. The Livermore Valley forms an irregularly shaped lowland area approximately 26 km long and an average of 11 km wide. The floor of the valley slopes from an elevation of approximately 200 m above sea level at the eastern end to approximately 90 m above sea level at the southwest corner.

The climate of the Livermore Valley is characterized by mild, rainy winters and warm, dry summers. The mean annual temperature is about 15°C. Temperatures typically range from –5°C during some pre-dawn hours in the winter, to 40°C on a few summer afternoons. The 2001 annual wind data for the Livermore site are displayed as a wind rose in Figure 2. Although winds are variable, the prevailing wind direction is from the southwest, especially during the summer. However, during the winter, the wind often blows from the northeast. Most precipitation occurs as rain between October and April with very little rainfall during the summer months. In 2001, the Livermore site received 339 mm of precipitation.

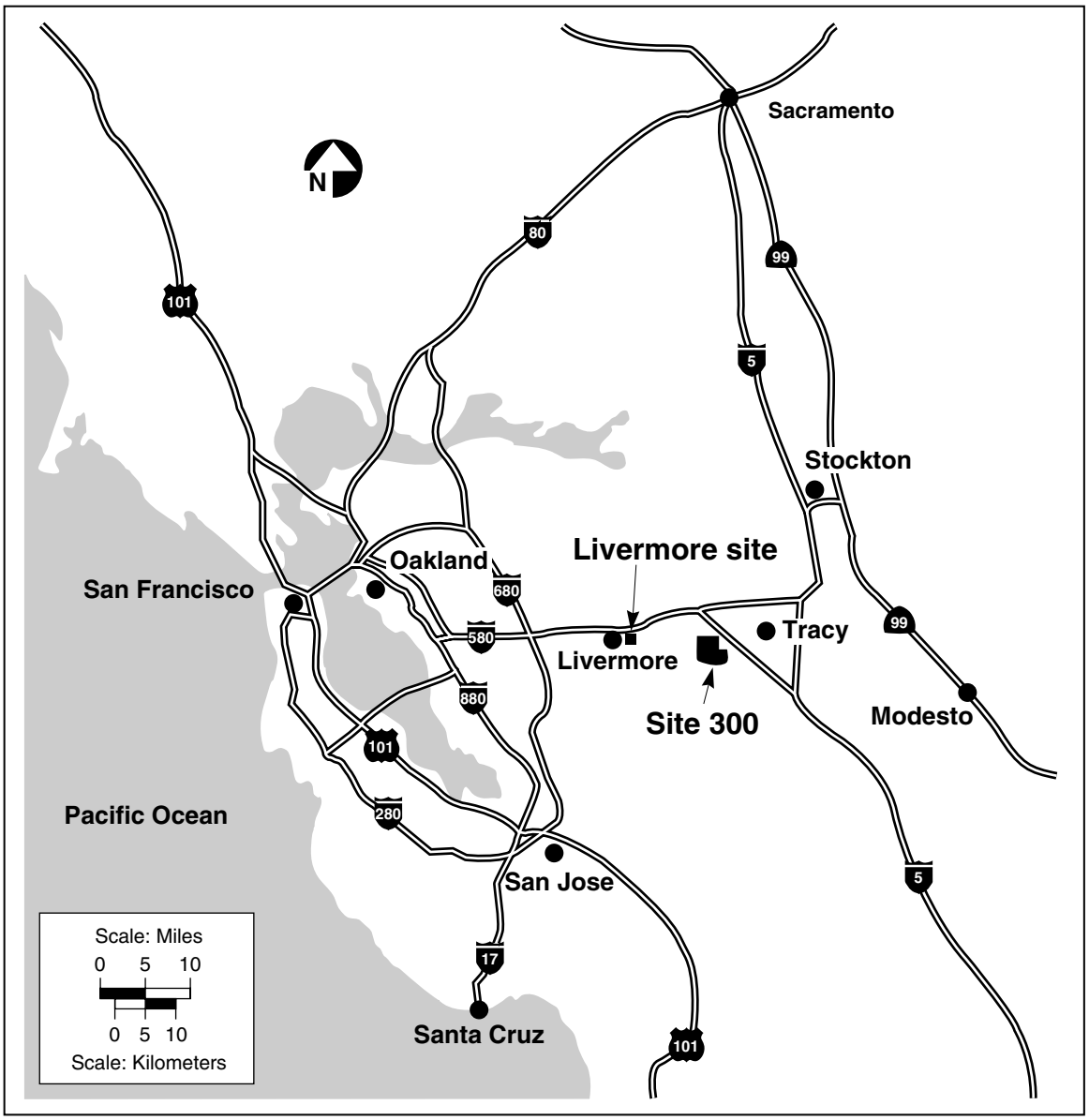

Figure 1. Locations of LLNL Livermore site and Site 300.

Site 300

Site 300, LLNL's Experimental Test Facility, is located 24 km east of the Livermore site in the Altamont Hills of the Diablo Range and occupies an area of 30.3 km^2. It is close to another explosives-testing facility owned and operated by SRI International. A State of California vehicular-recreation area is located nearby, and wind-turbine generators line the surrounding hills. The remainder of the surrounding area is in agricultural use, primarily pasture land for cattle and sheep. The nearest residential

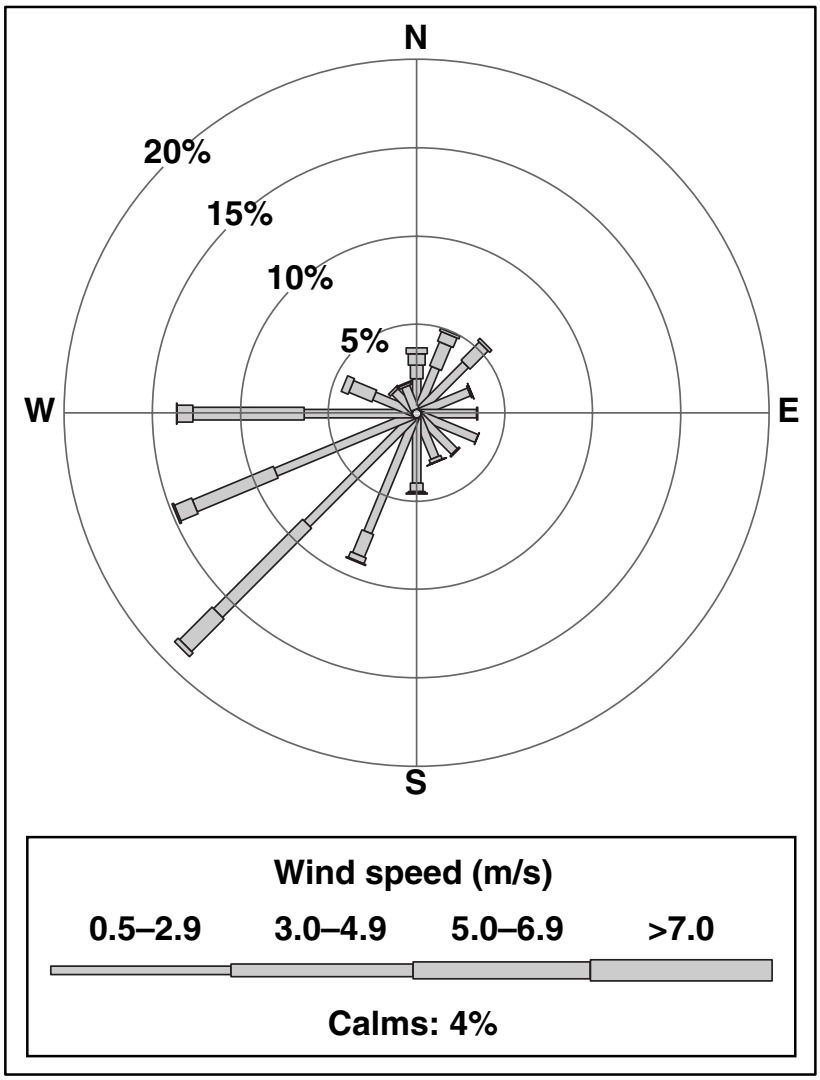

Figure 2. Wind rose showing the average annual wind speed, frequency of occurrence, and direction at the Livermore site, 2001.

area is the city of Tracy (population approximately 61,200), located 10 km to the northeast.

The topography of Site 300 is much more irregular than that of the Livermore site; it consists of a series of steep hills and ridges, which are oriented along a generally northwest/southeast trend, separated by intervening ravines. The elevation ranges from approximately 540 m in the northwestern portion of the site to 150 m at the southeast corner. The climate at Site 300 is similar to that of the Livermore site, with mild winters and dry summers. The complex topography of the site significantly influences local wind and temperature patterns, making the temperature range

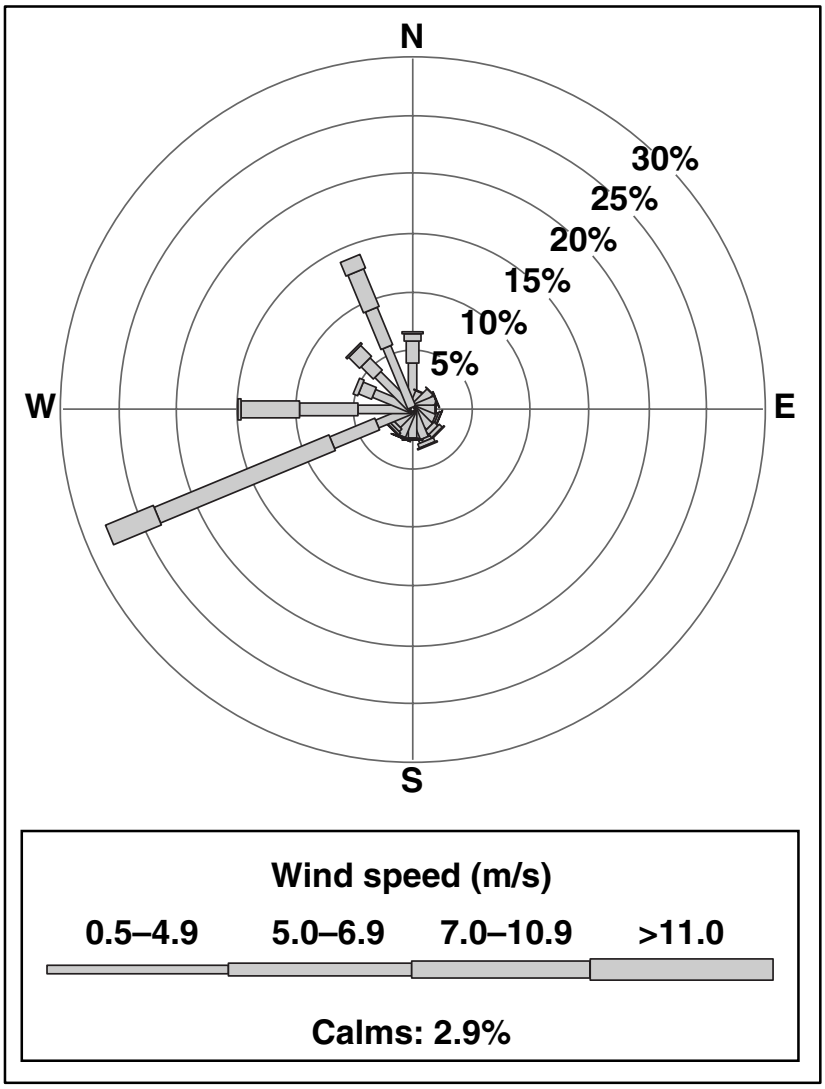

Figure 3. Wind rose showing the average annual wind speed, frequency of occurrence, and direction at Site 300, 2001.

somewhat more extreme than at the Livermore site. The 2001 annual wind data for Site 300 are displayed as a wind rose in Figure 3. Prevailing winds are from the west-southwest. As is the case at the Livermore site, precipitation is highly seasonal, with most precipitation occurring between October and April. Site 300 received 247 mm of precipitation during 2001. The mean annual temperature is about 17°C.

SECTION II. Air Emission Sources and Data

Sources

More than a hundred different radioisotopes are used at LLNL for research purposes, including biomedical tracers, tritium, mixed fission products, transuranic isotopes, and others—see the "radionuclides" column in the Attachment 1 spreadsheet for a breakdown by facility. Radioisotope handling procedures and work enclosures are determined for each project, depending on the isotopes, the quantities being used, and the types of operations being performed. Radioisotope handling and working environments include glove boxes, exhaust hoods, and laboratory bench tops. Exhaust paths to the atmosphere range from triple HEPA (High Efficiency Particulate Air) filtered ventilation systems, to roof vents and stacks lacking abatement devices, to direct dispersal of depleted uranium during explosives testing at Site 300, to a variety of diffuse area sources.

Sources of radioactive material emissions to air at LLNL are divided into two categories for purposes of evaluating NESHAPs compliance: point sources (including stacks, roof vents, and explosive experiments conducted on Site 300's firing tables) and diffuse area sources (including dedicated waste accumulation areas and other areas of known contamination). Hazardous Waste Management's "Tank Farm" operations at Building 514 and waste storage at the Building 612 Yard, and other Livermore-site sources external to buildings, are treated as diffuse area sources. Detailed information is given in Attachment 1 for emissions from LLNL's radiological operations that took place during 2001.

2001 Air Monitoring

In this section we describe continuous stack-effluent sampling systems at selected LLNL facilities and ambient air monitors in place at numerous locations on and off LLNL sites.

Continuous Stack Air Effluent Monitoring

Actual measurements of radioactivity in air and effluent flow are the basis for reported emissions from continuously monitored sources. In 2001, there were seven buildings (Buildings 175, 177, 235, 251, 331, 332, and 491) at the Livermore site that had radionuclide air effluent monitoring systems. These buildings are listed in Table 1, along with the number of samplers, the types of samplers, and the analytes of interest. Many samplers would operate from emergency power systems if normal power were lost.

Air samples for particulate emissions are extracted downstream of HEPA filters and prior to the discharge point to the atmosphere. Particles are collected on membrane filters. The sample filters are removed and analyzed for gross alpha and beta activity

Table 1. Air effluent sampling locations and systems.

Building	Facility	Analytes	Sample type	Number of samplers
175	MARS [a]	Gross α, β on particles	Filter	6
177	Extractor Test [a]	Gross α, β on particles	Filter	1
235	Chemistry and Materials Science	Gross α, β on particles	Filter	1
251	Heavy Elements			
	Unhardened area	Gross α, β on particles	Filters	28
	Hardened area	Gross α, β on particles	Filters	4
331	Tritium	Tritium	Ionization Chamber[b]	4
		Gaseous tritium/ tritiated water vapor	Molecular sieves	4
332	Plutonium	Gross α, β on particles	CAM[b]	12
		Gross α, β on particles	Filters	16
491	Isotope Separation[a]	Gross α, β on particles	Filters	1

Note: "CAM" denotes Eberline continuous air monitors.
[a] Operations discontinued, however, air effluent sampling systems at this building continue to operate as part of the maintenance and surveillance shutdown plan for AVLIS facilities
[b] Alarmed systems.

on a weekly or bi-weekly frequency depending on the facility. In most cases, simple filter aerosol collection systems are used. However, in some facilities, alpha continuous air monitors (CAMs) are used for sampling. In addition to collecting a sample of particles, the CAM units provide an alarm capability for the facility in the event of a release of alpha activity.

Detection of gross alpha and beta activity resulting from particles collected on the air filters is accomplished using gas flow proportional counters. Analysis is delayed for at least four days from the end of sample collection to allow for the decay of naturally occurring radon daughters. For verification of the operation of the counting system, calibration sources, as well as background samples, are intermixed with the sample filters for analysis. Analysis is performed by the Radiological Measurements Laboratory (RML) in the Hazards Control Department (HCD).

Each stack of the Tritium Facility (Building 331) is monitored for tritium release by both an alarmed continuous monitoring system and by molecular sieve continuous samplers. The alarmed monitors, which are Overhoff ion chambers, provide real

time tritium concentration release levels (HT, HTO, or other gaseous forms). The sieve samplers discriminate between tritiated water (HTO) vapor and molecular tritium (HT); they provide the values used for environmental reporting and are exchanged weekly. Each sieve sampler (not alarmed) is in parallel with an alarmed monitor and consists of two molecular sieves. The first sieve collects tritiated water vapor; the second sieve contains a palladium-coated catalyst that converts molecular tritium to tritiated water, which is then collected. The molecular sieve samples are submitted to the Hazards Control Analytical Laboratory where they are put into a recovery system for the bake out of tritiated water vapor and subsequent condensation and collection of the water. The retrieved tritiated water is analyzed by RML using liquid scintillation counting techniques.

Data from air particulate sampling filter and molecular sieve analyses are reviewed by Hazards Control Department Health Physicists responsible for each facility and an Environmental Protection Department Environmental Analyst.

Results of Stack Monitoring for Tritium: Operations in the Tritium Facility (Building 331) in 2001 released a total of 20 Ci (7.4×10^{11} Bq) of tritium. Of this, approximately 18.3 Ci (6.8×10^{11} Bq) were released as tritiated water (HTO). The remaining 8.5% of the tritium released, 1.7 Ci (6.4×10^{10} Bq), was elemental tritium gas (HT). The highest single weekly stack emission from the facility was 0.67 Ci (2.5×10^{10} Bq), of which 0.64 Ci (2.4×10^{10} Bq) was HTO.

Building 331 tritium emissions, as measured by stack monitoring, remained considerably lower in 2001 than emissions that occurred during the 1980s. The reduced emissions in 2001 were primarily the result of a reduction in programmatic work compared to the previous years. Over the next five years, an increasing trend in emissions may occur as research and development work is performed for new programmatic efforts. However, engineered controls designed to contain and recapture tritium leakage should maintain relatively low emissions. Figure 4 illustrates the combined HTO and HT emissions from the facility since 1981.

Stack Monitoring for Gross Alpha and Gross Beta Radiation: For most discharge points at the other facilities where continuous stack sampling is performed, the results are below the minimum detectable concentration (MDC) of the analysis; sometimes as few as 1 to 4 samples (out of 25 to 50 per year) have concentrations greater than the MDC. Generally, these few samples having results above the MDC are only marginally above the MDC. Use of zero values for this type of data can be justified based on knowledge of the facility, the use of tested, multiple stage, HEPA filters in all significant release pathways, and alpha spectroscopy based isotopic analyses of selected air sampling filters. These isotopic analyses demonstrate that detected activity on air sampling filters comes from

naturally occurring radionuclides, such as radon daughters, e.g., polonium, on the air sampling filters. In addition, because of exhaust configurations at some facilities, the monitoring systems sometimes sample air from the ambient atmosphere along with the HEPA filtered air from facility operations, giving rise to background atmospheric radioactivity being collected. Because of these considerations, the emissions from such facility operations are reported as zero. Consequently, there are no dose consequences, and doses reported for these operations are also zero. Furthermore, even if the MDC values are used in calculations of the emission estimates for these facilities, which would be an extremely conservative approach, the total dose attributable to LLNL activities is not significantly affected. None of the facilities monitored for gross alpha and beta had emissions in 2001.

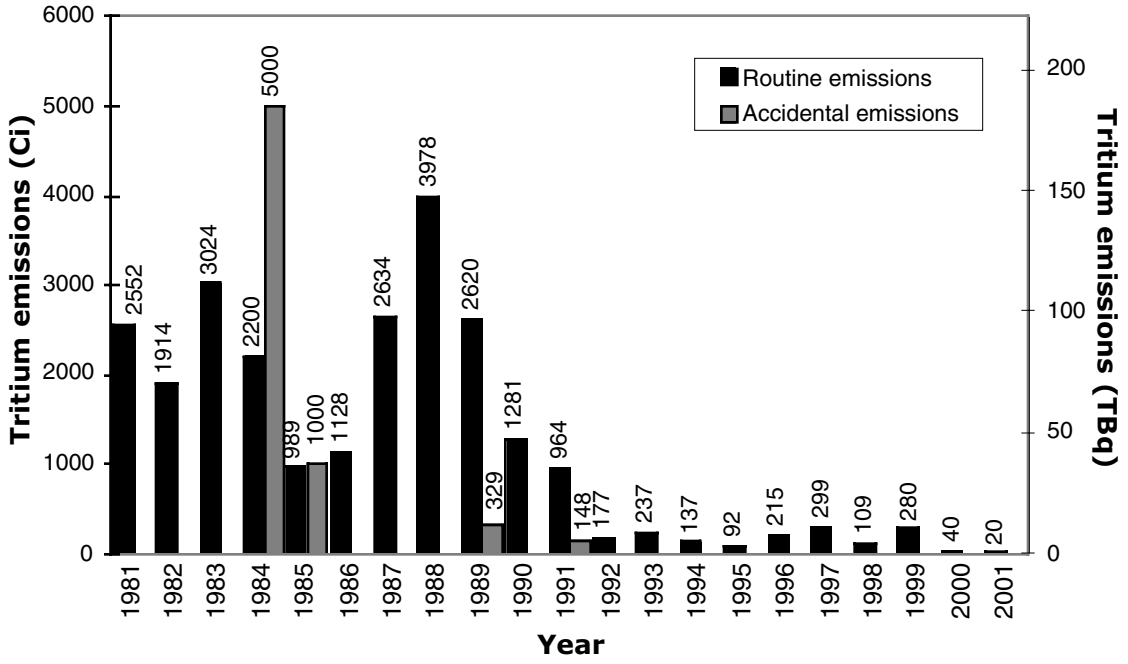

Figure 4. Combined HT and HTO emissions from the Tritium Facility, 1981–2001, distinguishing between chronic releases during normal operations (black bars) and acute accidental releases (gray bars). Accidental releases are predominantly HT gas.

Air Surveillance Monitoring for Radioactive Particles and Gases

Surveillance air monitoring for tritium and radioactive particles has been in place since the 1970s and will continue. LLNL currently maintains seven continuously operating, high volume, air particulate samplers on the Livermore site, nine in the Livermore Valley, eight at Site 300, and one in Tracy. LLNL also maintains twelve continuously operating tritiated water vapor samplers on the Livermore site, six

samplers in the Livermore Valley and one at Site 300. The samplers are positioned to ensure reasonable probability that any significant airborne concentration of particulate or tritiated water vapor effluents resulting from LLNL operations will be detected. Many of the surveillance air monitors are placed near diffuse emission sources, such as those near Buildings 292, 331, 514, and 612, as well as in and around the Southeast Quadrant of the Livermore site. As such, their results can be used to estimate and/or confirm the emissions from the associated diffuse sources. Also included is an air particulate monitor positioned at the location of the hypothetical maximally-exposed member of the public (defined in Section III) for the Livermore site. Data from air surveillance monitors provide a valuable test of predictions based on air dispersion modeling, and can help characterize unplanned releases of radioactive material.

The data from the ambient air monitoring network provide continuous measurements of the concentrations of radionuclides present in the air at the Livermore site, Site 300, and in the surrounding areas. Data from the network are presented in the LLNL Site Annual Environmental Report, which is available to the public in bound hardcopy form and on the Internet. (See, e.g., Biermann et al., *Environmental Report 2000*, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-50027-00, September 2001; http://www.llnl.gov/saer).

Recognition of Need to Apply Correction Factors to Results of Tritium Surveillance Air Monitoring: Recently it was shown that measured tritium concentrations obtained using a method involving the extraction of water from silica gel—a method used at LLNL since 1973— are in error and require upward correction. It is important to note that this correction, while affecting the concentrations of tritium in ambient air quoted in LLNL's environmental reports, does not significantly change the doses to the public quoted in those reports. Only for the special case of a diffuse tritium source having emissions inferred from monitoring data does the correction change the inferred dose for that particular source. Doses to the public attributed to tritium emissions from the pair of 30-meter-high stacks of the Tritium Facility, in particular, are not affected.

The Environmental Monitoring Radiological Laboratory of the Analytical and Nuclear Chemistry Division at LLNL developed a correction factor that applies to all measured tritium concentrations obtained by this method (Guthrie, E.B., et al., "Isotope exchange and fractionation corrections for extraction of tritiated water in silica gel by freeze-drying techniques," LLNL draft report, Sept. 2001). The correction factor was developed based on new understanding of the properties of silica gel (Rosson, R., et al., "Isotopic exchange and the vapor pressure isotope effect in tritium oxide adsorption on silica gel.," J. Phys. Chem. B102:10342-10346, 1998; Rosson, R., et al., (2000), "Correcting tritium concentrations in water vapor monitored with silica gel," Health Physics 78(1):68-73). Put simply, the

concentration of tritium measured in water extracted from the silica gel has been found to be lower than the concentration of the air moisture absorbed by the silica gel. This phenomenon occurs because tritium from ambient air exchanges with water bound in the silica gel that cannot be removed by the drying process. The bound water fraction is about 5 or 6% by weight depending upon the type of silica gel. The magnitude of the correction depends upon the amount of water collected compared with the amount of exchangeable water bound in the silica gel and is specific to the silica gel used by LLNL. For 2001, the average correction factor was 1.6 (range of 1.3 to 2.3, with 97% of the correction factors being less than 1.9). The correction factor was applied to each sample based upon the amount of water collected and the initial weight of the dry silica gel.

An illustration of the quantitative effect produced by these corrections annually over the period 1997-2000 is given in Section VIII, in the subsection comparing modeled results to measured concentrations of tritium in air at a dozen surveillance air monitor locations on or near the Livermore site.

As a note of clarification, while the silica gel correction factors apply to measured concentrations of tritium in ambient air, they do not apply to results of air effluent monitoring of the Tritium Facility stacks, since the molecular sieve material used in the stacks does not contain silica gel. Of course, these correction factors also have no effect on results calculated using the tritium models in CAP88-PC, NEWTRIT, or other codes; these models are not based on or coupled with any particular measurement method.

Radionuclide Usage Inventory Update

A "partial" accounting of LLNL's radiological emission sources was made in 2001, in accordance with the allowance by EPA that a 100% accounting need be made only every third year. The previous year, when reviewing and reporting on operations conducted in 2000, a 100% accounting was made.

The partial accounting focused on sources in four categories: (1) the group of sources that collectively (in a ranked list) accounted for at least 90% of the dose to the maximally-exposed public individual from both the Livermore site and Site 300 in the previous year's (2000) assessment; (2) all "new" sources, i.e., those that commenced emissions in 2001, or sources that showed significantly elevated releases over 2000 levels; (3) all monitored sources; and (4) all sources in the major LLNL waste stream dealt with by Hazardous Waste Management (HWM).

Radionuclide usage inventory forms, with guidance for completing them, were sent to all assurance managers, facility managers, and project-responsible persons connected with activities meeting these criteria for our partial accounting. The forms were completed by experimenters, and certified by facility managers. In particular,

radionuclide usage data for all Site 300 explosives experiments and all significant stack and diffuse sources at both sites were included in this update.

SECTION III. Dose Assessment Methods & Concepts

Description of the Air Dispersion and Dose Model

Most estimates of individual and collective radiological doses to the public from LLNL operations were obtained using the EPA-developed computer code CAP88-PC. An LLNL- modified version of this code (designated CAP88-PC-T), which contains an improved tritium model (not yet approved by EPA for use in regulatory compliance evaluations), was also used for purposes of comparison. The four principal pathways—internal exposures from inhalation of air, ingestion of foodstuff and drinking water, external exposures through irradiation from contaminated ground, and immersion in contaminated air—are evaluated by CAP88-PC. The doses are expressed as whole-body effective dose equivalents (EDEs), in units of mrem/y (1 mrem = 10 μSv). Separate doses for Livermore site and Site 300 emissions are reported.

Three potential doses are emphasized: (1) The dose to the site-wide maximally exposed individual (SW-MEI), which combines the effects of all emission points, for comparison to the 10 mrem/y (100 μSv/y) standard; (2) the maximum dose to any member of the public (assumed to be at the LLNL fence line), in any direction, due to each unabated emission point on the site to determine the need for continuous monitoring; and (3) the collective dose to populations residing within 80 km of the two LLNL sites, adding the products of individual doses received times the number of people receiving them.

Summary of Model Input Parameters

General Model Inputs: Attachment 1 details the key identifiers and input parameters for the CAP88-PC model runs. These include building number; stack ID; isotope(s); emission rate in curies per year (1 Ci = 3.7×10^{10} Bq); and stack parameters, including height, diameter, and emission velocity.

Meteorological Data: All model runs used actual 2001 Livermore-site and Site 300 meteorological data, collected from the meteorological towers for each site. At these towers, wind speed and direction are sampled every few seconds, temperature sampled every minute, and all are averaged into quarter-hour increments, time tagged, and computer recorded. The data are converted into a CAP88-PC input wind file using EPA guidelines.

Surrogate Radionuclides: CAP88-PC contains a library of 265 radionuclides; however, it does not contain all the radionuclides in use at LLNL. As a consequence, it was necessary in a few cases to use surrogate radionuclides to estimate EDEs.

Attachment 2 shows the surrogate radionuclides used in CAP88-PC. The selection of a suitable surrogate is based upon several criteria, including metabolically similar behavior and similar modes of decay and decay energies of the radiation type of the isotope of interest. Once a surrogate is selected, the equivalent source term is adjusted by the product of the initial inventory of the isotope of interest and the ratio of the effective dose equivalent of the surrogate to that of the isotope of interest. In some cases, experimenters did not have isotopic analyses of mixtures of radionuclides, and they identified the radionuclides used as "gross alpha," "gross beta," "gross gamma," or "mixed fission products" (MFP). In these cases, ^{239}Pu was used as the surrogate for gross alpha, ^{137}Cs was used as the surrogate for gross gamma, and ^{90}Sr was used as the surrogate for gross beta and mixed fission products to provide conservative dose estimates.

Population Inputs: Population distributions centered on the two LLNL sites were compiled from the LandScan Global Population 1998 Database developed by Dr. Jerome Dobson at Oak Ridge National Laboratory. The population data files (distribution of population with distance and direction) used in the 2001 modeling effort are the same as those described in last year's NESHAPs annual report (*LLNL NESHAPs 2000 Annual Report*, Gallegos et al., June 2001).

Land Use and Agricultural Inputs: Options for model inputs regarding agricultural characteristics and land use are established by the EPA, and the particular designation selected can strongly influence the ingestion dose received by the population being evaluated. The "user entered" option was again selected for the CAP88-PC modeling effort for 2001. The values entered corresponded to the "local agriculture" option (i.e., everything is home produced), with one exception—all milk consumed was assumed to be imported for individual dose assessment. The assumption that all milk comes from local cows is not supported by the agricultural activities conducted in the area. For population dose assessments, all food is considered to be locally grown, which means grown within an 80 km radius about the site; default densities of agricultural products in California are used.

Emission Source Terms: The source term for each emission point in the calculations was determined by one of two methods: For continuously monitored sources, the sampling data (curies released per unit time) for each radionuclide were used directly. For unmonitored facilities, the radionuclide usage inventories, together with time factors and EPA-specified physical state factors, are used to estimate the potential emissions to air from a source. The time factors are used to adjust for the fact that the radionuclide may not always be in the same facility all year or may be encapsulated or enclosed for a substantial part of the year. The time factors are chosen to allow a reasonable estimate of the amount of radioactive material that may potentially be released into the atmosphere. The EPA-specified factors for potential release to air of materials in different physical states (solid,

liquid, powder, or gas) are those stated in 40 CFR Part 61, Appendix D. If the material was an unconfined gas, then the factor 1.0 was used; for liquids and powders, 1.0×10^{-3} was used; and for solids, 1.0×10^{-6} was used. The U.S. EPA has granted approval for LLNL to use alternative physical state factors for elemental uranium, uranium/niobium alloy, and elemental plutonium. Table 2 provides the approved temperatures for application of the physical state factor for each material.

These factors are allowed provided that the material is not intentionally dispersed to the environment and that the processes do not alter its chemical form. The physical state dependent release fraction and the time factor are used to adjust (by multiplication) the total annual usage inventory to yield the potential annual release to air. In addition, emission control abatement factors (40 CFR 61, Appendix D), when applicable, were applied. Each HEPA filter stage was given a 0.01 abatement factor. (However, abatement factors were not used to evaluate compliance with the 0.1 mrem [1 μSv] standard that determines the need for continuous monitoring at a facility.) The use of actual stack effluent sampling data is much more direct, and presumably more accurate, than using assumptions based on usage inventory, time factors, release fractions, and emission control factors.

Table 2. List of materials exempted from the "treat as a gas above 100°C rule," and temperatures at which the various physical state factors apply.

Material	Solid physical state factor	Liquid physical state factor	Gas Physical state factor	Year Approved
Elemental uranium	<1100°C	Between 1100°C and 3000°C	>3000°C	1996
Uranium/niobium alloy		<1000°C	Between 1100°C and 3000°C	2001
	>3000°C			
Elemental plutonium	<600°	Between 600°C and 3000°C	>3000°C	2001

Site-Wide Maximally Exposed Individual: For LLNL to comply with the NESHAPs regulations, the LLNL site-wide maximally exposed individual cannot receive an EDE greater than 10 mrem/y (100 μSv/y). The site-wide maximally exposed individual (SW-MEI) is defined as the *hypothetical* member of the public at a single residence, school, business, or office who receives the greatest LLNL induced EDE from the combination of all radionuclide source emissions, as determined by modeling.

At the Livermore site, the SW-MEI for 2001 was found, as usual, to be located at the UNCLE Credit Union, about 10 m outside the controlled eastern fence line of the site, but about 10 m within the perimeter of the site property, as shown in Figure 5. At Site 300, the 2001 SW-MEI was again, as in the previous year, located at the boundary with the Carnegie State Vehicle Recreation Area, managed by the

California Department of Parks and Recreation, approximately 3.2 km south southeast of the firing table at Building 851, as shown in Figure 6.

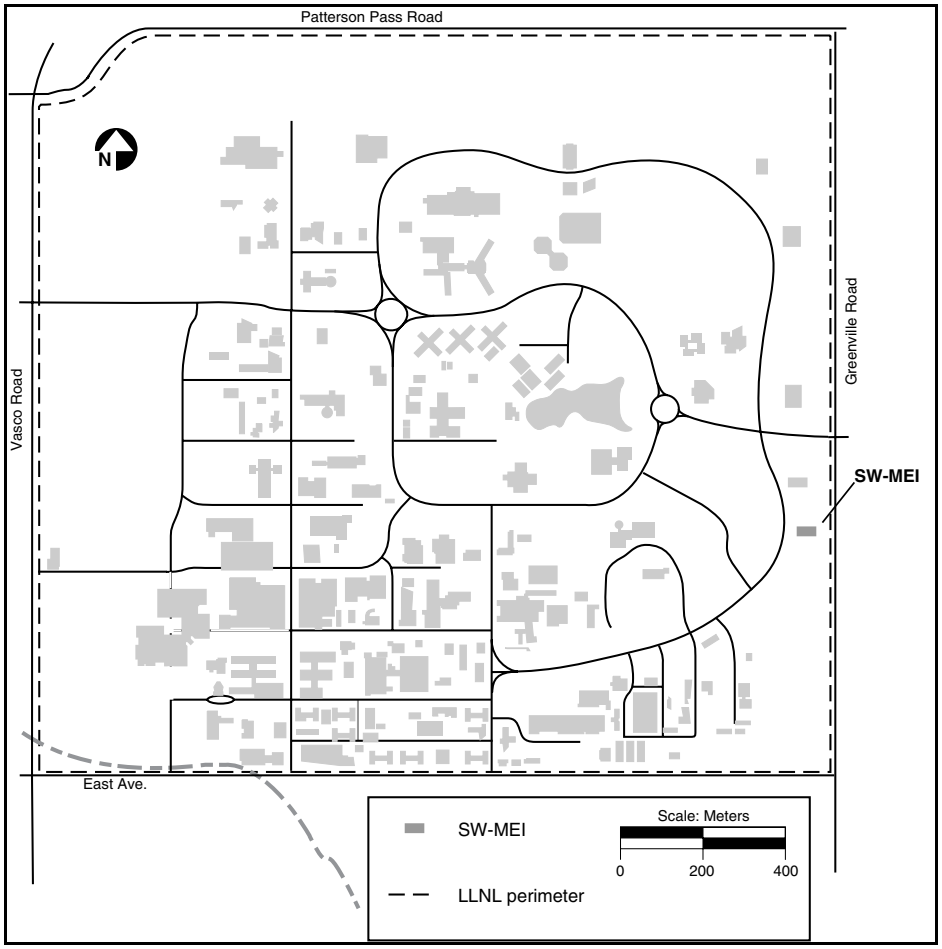

Figure 5. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at the Livermore site, 2001.

In the Attachment 1 spreadsheet, the distance and direction to the respective SW-MEI are shown for each facility at each site. Doses to the site specific SW-MEIs were evaluated for each source and then totaled for site specific evaluations against the 10 mrem/y (100 μSv) dose standard (see "Total Dose Estimate" in Section IV).

Maximally Exposed Public Individual: To assess compliance with the EPA requirement for continuous monitoring of a release point (potential dose greater than 0.1 mrem/y [1.0 μSv/y]), emissions must be individually evaluated from each point source; the location of the maximally exposed public individual (MEI) is generally different for each emission point. The maximum dose at a location of

unrestricted public access typically occurs at a point on the site perimeter. Therefore, it is often referred to as the maximum "fence line" dose, although the off-site maximum dose could occur some distance beyond the perimeter. (This could happen, e.g., when a stack is close to the perimeter; however, for all emission points at the Livermore site and Site 300, calculations show that ground level concentrations of radionuclides generally decline continuously beyond LLNL boundaries.) As stipulated by the regulations in 40 CFR Section 61.93 (b)(4)(ii), modeling for assessment of continuous monitoring requirements assumed unabated emissions (i.e., no credit was taken for emission abatement devices, such as filters). The Attachment 1 spreadsheet provides, for each point source, the dose to the MEI and the distance and direction to the LLNL fence line where the MEI is located.

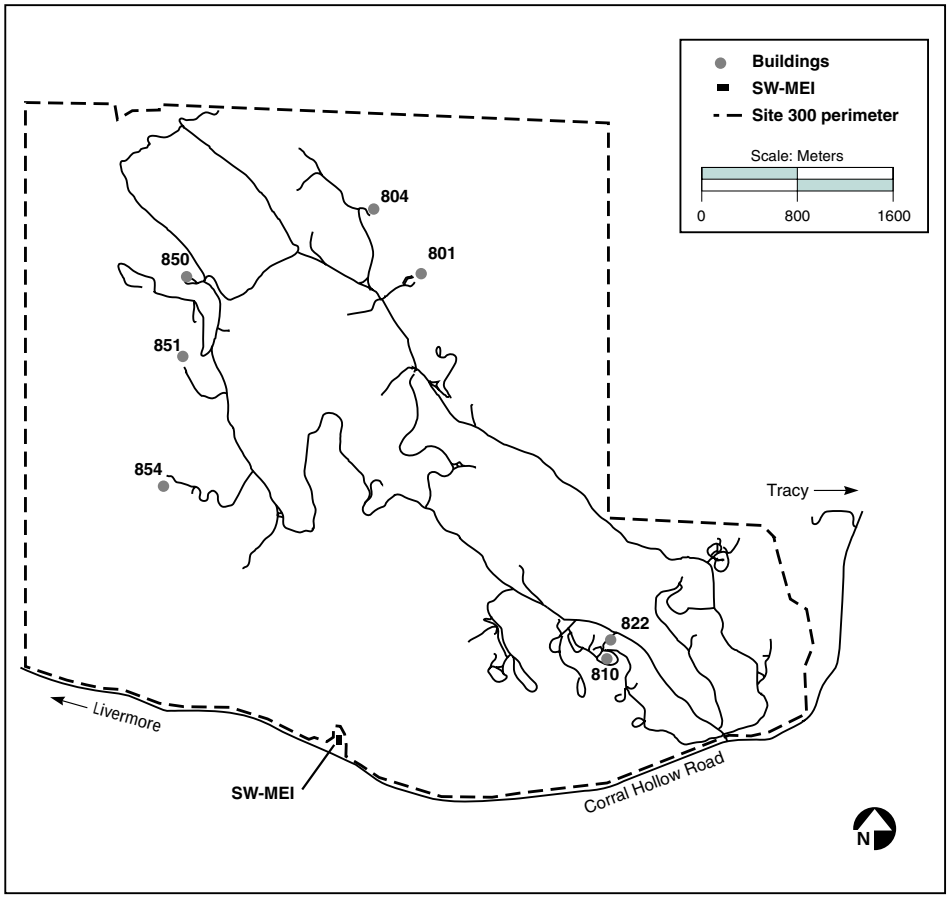

Figure 6. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at Site 300, 2001.

Special Modeling Challenges

Among the sources at LLNL, explosives tests using depleted uranium at Site 300 and diffuse sources at both sites required special attention.

Site 300 Explosives Experiments: Some of the assemblies for Site 300 explosives experiments contain depleted uranium (DU) and possibly other radioactive materials. (The radioactive material does not contribute to the explosive energy, which is entirely chemical in origin.) The explosives assemblies are placed on an open-air firing table and detonated. Only limited data are available to characterize the initial state of the cloud of explosive decomposition products created by the detonation because properties of the cloud are not routinely measured in the experiments. Empirical scaling laws can be used, however, to define the size and height of the cloud using explosives inventories. When the assembly contains DU, the three uranium isotopes with atomic weights 238, 235, and 234 are assumed to occur in the cloud in the weight percentages 99.8, 0.2, and 5×10^{-4}. Their masses are multiplied by their specific activities to determine the total activity for each isotope in the cloud. For simplicity, it is assumed that all the uranium is dispersed as a gaseous cloud, and that the median particle size is the CAP88-PC default value of 1 μm. The assumption that all uranium is aerosolized and dispersed as a cloud results in a highly conservative off-site dose estimation—we believe a more realistic release-to-air fraction for the uranium is no greater than 0.2, but we lack sufficient data to use a value other than 1.0. CAP88-PC simulates each shot as a low level, steady state, stack-type emission occurring over one year. An alternative modeling methodology for treating these short duration explosive events, based on a "puff" code, was submitted to EPA for approval in 1992, but LLNL was directed to use the CAP88-PC code for these calculations.

Diffuse Sources: Diffuse emissions generally arise from extended-area sources external to buildings. Such sources are difficult to quantify. At present there are no EPA-mandated methods for estimation or measurement of diffuse sources; dose calculations associated with this type of source are left to the discretion of the DOE facility. Dose assessments for Livermore-site and Site 300 diffuse sources are variously derived based on radionuclide usage inventory data, environmental surveillance monitoring data, samples of contaminated materials, and other methods. The doses from principal diffuse sources in 2001 are described below in Section VIII.

Modeling Documentation

Dose assessment modeling runs were conducted for all sources (point and diffuse) meeting the criteria of the reduced accounting for 2001. The model used was EPA's CAP88-PC code (see Section III). Files were incorporated for meteorological data (wind, precipitation, and temperature) and population data representing both sites,

along with the 2001 radionuclide usage inventory or stack effluent monitoring data. Annual dose is reported as whole-body EDE expressed in units of mrem (followed by μSv; 1 mrem = 10 μSv). Copies of individual model runs, including input parameters and resultant calculated doses, are on file with the Terrestrial & Atmospheric Monitoring & Modeling Group (TAMM) of the Environmental Protection Department at LLNL.

SECTION IV. Results of 2001 Radiological Dose Assessment

This section summarizes the doses to the most exposed public individuals from LLNL operations in 2001, shows the temporal trends and comparison to previous years, presents the potential doses to the populations residing within 80 km of either the Livermore site or Site 300, and summarizes LLNL's compliance with 40 CFR 61, Subpart H (61.93).

Total Dose to Site-Wide Maximally Exposed Individuals

For the Livermore site, the dose calculated for the SW-MEI from diffuse emissions in 2001 totaled 0.011 mrem (0.11 μSv). The dose due to point sources was 0.0056 mrem (0.056 μSv). When combined, the total annual dose was 0.017 mrem (0.17 μSv), 66% from diffuse and 34% from point sources. The point source dose includes Tritium Facility HT emissions modeled as HTO, as directed by EPA Region IX. The SW-MEI dose calculated using NEWTRIT for tritium emissions from both point and diffuse sources at the Livermore site was 0.013 mrem (0.13 μSv).

The total dose to the Site 300 SW-MEI from operations in 2001 was 0.054 mrem (0.54 μSv). Point source emissions from firing table explosives experiments accounted for 0.050 mrem (0.50 μSv), or 93%, of this total, while 0.0037 mrem (0.037 μSv), or about 7%, was contributed by diffuse sources.

Table 3 shows the facilities or sources that accounted for more than 90% of the doses to the SW-MEI for the Livermore site and Site 300 in 2001. Although LLNL has nearly 200 sources with potential for releasing radioactive material to air according to NESHAPs prescriptions, most are very minor. Nearly the entire radiological dose to the public from LLNL operations comes from no more than a dozen sources.

A comparison of 2001 doses with those of previous years is provided by Table 4. No diffuse emissions were reported at Site 300 for years before 1993, so comparison of total Site 300 dose can only be made for 1993 and later. In addition, diffuse source doses were not reported separately from the total dose for the Livermore site for 1990 and 1991.

Doses from Unplanned Releases

There were no unplanned atmospheric releases of radionuclides at the Livermore site or Site 300 in 2001.

Table 3. List of facilities or sources whose emissions accounted for more than 90% of the SW-MEI doses for the Livermore site and Site 300 in 2001.

Facility (source category)	CAP88-PC Dose in mrem/y	CAP88-PC Percentage contribution to total dose
Livermore site		
Building 612 Yard (diffuse source)	0.0082*	48%
Building 331 stacks (point source)	0.0043*	25%
Building 514 Tank Farm (diffuse source)	0.0013	8%
Southeast Quadrant (diffuse source)	0.00088	5%
Building 612, R102 (point source)	0.00062	4%
Building 514 Evaporator (point source)	0.00058	3%
Site 300		
Building 851 Firing Table (point source)	0.050	93%
Soil resuspension (diffuse source)	0.0037	7%

* When LLNL's NEWTRIT model (see Section VIII, subsection on "Modeling dose from tritium") is used in CAP88-PC in place of CAP88-PC's default tritium model, the doses for Building 612 yard and Building 331stacks become 0.0061 mrem and 0.0031 mrem, respectively, and their percentages of the total dose from Livermore site operations each drop by 1%.

Population Doses

Population doses, or collective EDEs, for both LLNL sites were calculated out to a distance of 80 km in all directions from the site centers using CAP88-PC. As noted earlier, CAP88-PC evaluates the four principal exposure pathways: ingestion through food and water consumption, inhalation, air immersion, and irradiation by contaminated ground surface.

Population centers affected by LLNL emissions include the relatively nearby communities of Livermore and Tracy, the more distant metropolitan areas of Oakland, San Francisco, and San Jose, and the San Joaquin Valley communities of Modesto and Stockton. Within the 80 km outer distance specified by DOE, there are 6.9 million residents included for the Livermore site population dose determination, and 6.0 million for Site 300. Population data files (distribution of population with distance and direction) used for the present report were the same as in the previous year; see Tables 7 and 8 in *LLNL NESHAPs 2000 Annual Report* (Gallegos et al. 2001).

The CAP88-PC result for potential population dose attributed to 2001 Livermore-site operations was 0.16 person-rem (0.0016 person-Sv). This amount is less than typical,

primarily because the stack releases from the Tritium Facility were unusually low in 2001. The corresponding collective EDE from Site 300 operations in 2001 was 9.4 person-rem (0.094 person-Sv). This value, while within the normal range seen from year to year, exceeds by almost four times the 2.5 person-rem (0.025 person-Sv) for 2000, as a result of increased firing table activity.

These population doses can be compared to the collective dose from natural background radioactivity for 6.9 million people of 2.1×10^6 person-rem (2.1×10^4 person-Sv).

Table 4. Doses (in mrem) calculated for the Site-Wide Maximally Exposed Individual (SW-MEI) for the Livermore site and Site 300, 1990 to 2001.

Year	Total Dose	Point Source Dose	Diffuse Source Dose
Livermore site			
2001	0.017 [a]	0.0057 [a]	0.011
2000	0.038 [a]	0.017 [a]	0.021
1999	0.12 [a]	0.094 [a]	0.028
1998	0.055 [a]	0.031 [a]	0.024
1997	0.097	0.078	0.019
1996	0.093	0.048	0.045
1995	0.041	0.019	0.022
1994	0.065	0.042	0.023
1993	0.066	0.040	0.026
1992	0.079	0.069	0.010
1991	0.234	—[b]	—[b]
1990	0.240	—[b]	—[b]
Site 300			
2001	0.054	0.050	0.0037
2000	0.019	0.015	0.0037
1999	0.035	0.034	0.0012
1998	0.024	0.019	0.005
1997	0.020	0.011	0.0088
1996	0.033	0.033	0.00045
1995	0.023	0.020	0.003
1994	0.081	0.049	0.032
1993	0.037	0.011	0.026
1992	0.021	0.021	—[c]
1991	0.044	0.044	—[c]
1990	0.057	0.057	—[c]

[a] The dose includes HT emissions modeled as HTO as directed by EPA Region IX. EPA Region IX acknowledges that such modeling results in a conservative overestimation of the dose. This methodology is used for purposes of compliance.

[b] Diffuse source doses were not reported separately from the total dose for the Livermore site for 1990 and 1991.

[c] No diffuse emissions were reported at Site 300 for years before 1993.

Compliance with 40 CFR 61 Subpart H (61.93)

Calculations of effective dose equivalents for Livermore-site and Site 300 facilities having the potential to release radioactive material to the atmosphere were found to be well below the 10 mrem (100 μSv) NESHAPs dose standard for dose to the most-exposed individual members of the public. Tritium accounted for more than three-quarters of the Livermore-site calculated dose, while at Site 300 practically the entire calculated dose was due to the isotopes ^{238}U, ^{235}U, and ^{234}U, in depleted uranium.

In 2001, there were seven buildings (Buildings 175, 177, 235, 251, 331, 332, and 491) at the Livermore site that had radionuclide air effluent monitoring systems. These buildings are listed in Table 1, along with the number of samplers, the types of samplers, and the analytes of interest.

LLNL is committed to monitoring stack effluent air from its Tritium Facility (Building 331), Plutonium Facility (Building 332), and the seismically hardened area of its Heavy Element Facility (Building 251). In addition, other facilities are continuously monitored, as necessary, based on evaluations of potential emissions without control devices, as in the case of Building 235, or where classification or other issues prevent a usage-inventory-based evaluation.

SECTION V. Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: Dennis K. Fisher
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Signature: _____ **Date:** _____
Dennis K. Fisher

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. See 18 U.S.C. 1001.

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Phillip Hill

SECTION VI. Supplemental Information on New Projects and Facilities

NESHAPs Responsibilities of LLNL Programs/Projects

Proposed facilities and significantly modified operations are assessed for NESHAPs requirements during the National Environmental Policy Act (NEPA) review process. Under NEPA, all proposed projects or actions that might involve NESHAPs issues or concerns—not just pertaining to radionuclides but to toxic air contaminants as well—are reviewed and evaluated. If the proposal includes operations that require a NESHAPs assessment, necessary modeling is conducted. If insufficient information is available for modeling at the time the NEPA documents are prepared, LLNL includes in the NEPA documents a statement that NESHAPs review, modeling, and monitoring requirements will be met. It is the responsibility of the individual project proponent to supply the specific information required for any NESHAPs modeling, analysis, and review that must be completed before operations described in the document are initiated.

Air quality compliance requirements are spelled out in the ES&H Manual, Vol. III, Part 31.1, "Air Quality Compliance." For example, Sec. 4.0 in Part 31.1 on "Radioactive Air Pollutants" states the responsibilities, directs the project to contact TAMM Group for guidance and assistance, and gives an eleven-step list under Sec. 4.3, "Process for Compliance."

Major New Facilities

Three new LLNL facilities are currently under development. All of these were assessed prior to construction for compliance with NESHAPs. Effluent sampling systems are planned for all three. These facilities are the Contained Firing Facility (CFF) at Site 300, and the Decontamination Waste Treatment Facility (DWTF) and the National Ignition Facility (NIF) at the Livermore site.

The CFF project allows containment of some explosives tests currently conducted outdoors at Site 300's Building 801. The CFF project consists of an enclosed firing chamber, a support facility, and a diagnostic equipment facility. Construction of CFF is complete, and the facility began operations with non-radiological materials in February 2002. Operations using experiments with depleted uranium commenced in March 2002. Temporary stack monitors for radioactive particulate emissions have been installed; permanent monitors should be put in place during 2002.

The DWTF is a waste handling facility that will have improved air emissions controls and will enable the handling of additional waste streams. Phase I construction (site preparation and installation of underground utilities) has been completed. Construction of the solid waste processing building, the storage building, and the

office building were completed in 1998. Construction of the building housing the stack, air handling systems and liquid waste processing operations began in December 1999, following the issuance of the Resource Conservation and Recovery Act (RCRA) Hazardous Waste Facility permit from the State of California. The DWTF stack will be monitored for tritium and radioactive particulate emissions. It is anticipated that operations will commence in 2002.

The National Ignition Facility (NIF) will contain the world's largest laser, a research tool allowing scientists to recreate on earth conditions equivalent to the center of the sun. The NIF will focus 192 extremely powerful laser beams onto a BB-sized capsule of deuterium and tritium, forcing the two heavy isotopes of hydrogen to combine through compression and heating, producing ignition and self-sustained fusion burn. The NIF construction project began in 1996 and the conventional facility construction is more than 95% complete. Eighty percent of the large components of the beam path infrastructure have been procured and are either on site or on the way. Installation of this hardware has begun. The NIF Target Chamber has been set in position, vacuum leak-checked and is now ready for beampath infrastructure, utilities and diagnostics hardware. NIF is being designed, built and operated by a team from Lawrence Livermore, Los Alamos and Sandia National Laboratories and the University of Rochester. The NIF stack will be monitored for tritium emissions. NIF construction progress is the subject of a web page found at http://www.llnl.gov/nif/construction/index.html.

SECTION VII. NESHAPs QA/QC Activities

NESHAPs Quality Assurance (QA) Program

The LLNL NESHAPs quality assurance program is a multi-organizational effort that is described in the *Lawrence Livermore National Laboratory Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAPs), 40 CFR 61, Subpart H* (QAPP—Hall, L.C. and A.H. Biermann, UCRL-ID-13914, 2000). The QAPP is structured in the manner prescribed for quality assurance programs that is outlined in Appendix B, Method 114 of 40 CFR 61. The QAPP describes the organization structure and functional responsibilities, objectives of the quality assurance program, administrative controls in place for handling sample collection systems, sample collection and effluent flow rate measurement systems, corrective actions, and reporting.

The major components of this multi-organizational effort are the LLNL facilities/programs that have continuous monitoring systems, the Radiological Measurements Laboratory (RML) and the Analytical Laboratory (AL), both in the Hazards control Department (HCD), and the Environmental Protection Department (EPD). In addition to the QAPP, NESHAPs Agreement of Roles and Responsibilities (NARRs) documents are in place between EPD and the facilities and/or programs and HCD; these NARRs formalize responsibilities and obligations of the organizations regarding many tasks for the air effluent sample network. Tasks that are addressed in the NARRs include air sampler design and installation, procedures and their implementation, sampling, sample analysis and tracking, maintenance and repair of sampling systems, guidance on regulatory requirements, documentation of the sampling network, reporting, and the archival of records.

EPD is responsible for an annual assessment and demonstration of LLNL's compliance with NESHAPs. The Department operates under a Quality Assurance Management Plan and associated procedures and guidance documentation. The Terrestrial and Atmospheric Monitoring and Modeling Group (TAMM) of EPD is responsible for environmental monitoring; air dispersion and dose assessment modeling; assessment (in cooperation with Laboratory Program personnel) of usage and potential release of radioactive materials to air in operations throughout the Laboratory, and reporting to EPA and DOE/OAK to demonstrate the Laboratory's compliance with NESHAPs. Detailed records are kept of all measurements, CAP88-PC model runs, and calculations, and selected model runs are validated. The TAMM group is informed of proposed new operations, and modified operations where significant changes in radiological usage inventories occur, by several mechanisms. These mechanisms include the review of National Environmental Policy Act (NEPA) documentation, review of facility specific safety procedures and plan, review of LLNL Integrated Safety Management System

documentation, and representation on Environmental Support Teams. All NESHAPs evaluations and calculations, along with supporting information, are archived for at least the period of time specified in 40 CFR 61 Subpart H.

Quality Control (QC) for 2001 Radiological Usage Inventory and Modeling

Of the three-dozen potential sources for which emissions were estimated in the reduced accounting for 2001, approximately 15% were selected for validation, which entails confirmation of both the source emission data and dose modeling calculations. Two sources (one from each of the two LLNL sites) were selected because they represent the most significant contributions to 2001 potential dose to the public; two additional sources were selected as representative of radiological activities in HWM and Chemistry and Materials Sciences (C&MS); and one significant diffuse source was selected. Specifically, the sources chosen for quality control review were the following: the Tritium Facility's two 30-m stacks; one explosives experiment conducted at Site 300's Firing Table 851; HWM's Building 514 Evaporator; Chemistry and Materials Science's Building 151, Room 1241; and the Building 612 Yard waste storage area.

More broadly, the quality and accuracy of our accounting and inventory processes were checked in several ways. In the accounting of new sources, more than 200 NEPA documents were examined as they arose over the course of the year and reexamined collectively at year's end to identify all new 2001 projects having potential to release radioactive material to air. Additionally, all Radioactive Materials Management Areas new to 2001 were inventoried. The data characterizing the principal source at each site (principal in terms of producing the greatest potential dose to the public) were double checked. Finally, each radiological inventory form returned by the programs was scrutinized for consistency and evident errors as it was compiled and entered into the spreadsheet, Attachment 1. Based on these QC efforts, we believe that the data presented in Attachment 1 meets EPD's quality assurance objectives.

Proposal to EPA for use of a Graded-Risk Approach for NESHAPs Compliance

In 2001 LLNL made a proposal to EPA Region IX, for use of a graded-risk approach for demonstrating NESHAPs compliance. This proposal and EPA's response in rejecting it are reproduced in Attachment 3.

SECTION VIII: Supplementary Information on Radiological Dose Assessment for 2001

Livermore-Site Principal Diffuse Sources

The dose evaluations for diffuse sources at the Livermore site in 2001 required several different modeling approaches. Building 331 Outside Yard and Building 612 Yard emissions estimates were based on facility personnel knowledge and environmental surveillance data, respectively, to estimate emissions. Building 514 Tank Farm emissions estimates were derived from radiological usage inventory data. The dose in each of these cases was calculated using CAP88-PC. Air surveillance monitoring data for plutonium from a monitor located at the SW-MEI was used to evaluate the dose from plutonium contamination in the Southeast Quadrant.

Building 331 Outside Yard

As the Tritium Facility (Building 331) conducts operations, tritium-contaminated equipment and material slated for disposal is removed from the building, packaged in a waste accumulation and storage area, removed from the building to an outside storage container, and sent to Hazardous Waste Management Division (HWM) facilities. During 2001, outgassing from such waste released an estimated 1.0 Ci (3.7×10^{10} Bq) of tritium to the atmosphere outside Building 331. This amount was derived from process and facility knowledge and environmental surveillance measurements. This release was modeled in CAP88-PC as a 1 m^2 area source, leading to a calculated 2001 dose to the SW-MEI of 5.1×10^{-4} mrem (5.1×10^{-3} μSv); a dose of 3.8×10^{-4} mrem (3.8×10^{-3} μSv) was calculated when the NEWTRIT model was implemented in CAP88-PC.

Building 514 Tank Farm

Another potential source of diffuse emissions of a variety of radionuclides was HWM waste storage and treatment operations. Building 514 houses the HWM "Tank Farm," consisting of six 7,170-liter tanks with ancillary equipment such as pumps, mixers, probes, and a bulking station. The tanks are used to store and treat liquid and solid radioactive and/or mixed wastes. Treatment is performed on a batch basis. Chemicals and waste are added to the tanks to achieve the desired treatment objectives. A 2001 radionuclide usage inventory was conducted for the facility to determine the diffuse source term (Attachment 1). CAP88-PC modeling gave a 2001 SW-MEI dose for the Tank Farm to be 1.3×10^{-3} mrem (1.3×10^{-2} μSv).

Building 612 Yard

The Building 612 Yard is a potential source of diffuse emissions of tritium. This area is dedicated to hazardous waste, radioactive waste, and mixed waste management activities. The yard consists of several areas where waste containers are stacked outdoors. Several of these containers are not airtight and outgas tritium. A

surveillance air monitor designated B624 has been placed in the Building 612 Yard to provide continuous measurements of tritium in air near this source. The median annual concentration of tritium in air for 2001 in this area was 49 pCi/m^3 (1.8 Bq/m^3). These data were used to calculate the total tritium emissions from the area, using a conservative approach that assumed the source to be 60 m south-southwest of the air sampler. With this assumption, a diffuse source emission of 2.0 Ci/y (7.4×10^{10} Bq/y) was required to produce the concentrations measured at the air sampler. This source term produced a calculated 2001 dose to the SW-MEI from the Building 612 Yard of 8.2×10^{-3} mrem (8.2×10^{-2} µSv) as calculated with CAP88-PC ; a dose of 6.2×10^{-3} mrem (6.2×10^{-2} µSv) was calculated when the NEWTRIT model was implemented.

Southeast Quadrant

The Southeast Quadrant of the Livermore site has elevated levels of plutonium in the surface soil (from historic waste management operations) and air (from resuspension). A high volume air particulate sampler is located adjacent to the UNCLE Credit Union (the location of the SW-MEI) to monitor the plutonium levels in this area. Monitoring data from this air sampler were used as a direct measurement of potential dose via the air pathway. The median annual concentration of $^{239+240}Pu$ (the analytical technique used, alpha spectroscopy, does not distinguish between ^{239}Pu and ^{240}Pu) in air was 3.41×10^{-19} µCi/mL (1.26×10^{-14} Bq/mL). Using the dose conversion factor of 3.08×10^5 mrem/µCi (8.32×10^{-5} Sv/Bq) from Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. Environmental Protection Agency (1988) for ^{239}Pu and ^{240}Pu, and the standard man breathing rates of 8400 m^3/y, the dose was 8.8×10^{-4} mrem (8.8×10^{-3} µSv) for 2001.

Site 300 Principal Diffuse Sources

Diffuse sources at Site 300 involve primarily depleted uranium, and to a considerably lesser extent, tritium. During remediation efforts at Site 300, LLNL completed a contaminant screening to identify potential routes of migration from soil to air and other environmental media of these radionuclides and other contaminants (Final Site Wide Remedial Investigation Report; Webster-Scholten, Ed., 1994, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-108131). Uranium-238 and tritium were identified as contaminants of potential concern.

Tritium Evaporation and Migration at Site 300

Tritium gas and solids containing tritium (Li^3H) were components of explosives assemblies tested on the firing tables during past experiments. Most of the gaseous tritium escaped to the atmosphere during the tests, but some of the solid Li^3H remained as residue in the firing table gravel. Rainwater and dust-control rinse water percolated through the gravel, causing the tritium to migrate into the subsurface soil and, in some cases, eventually to the ground water. Tritium contaminated gravel was removed from the firing tables in 1988 and disposed in the

Pit 7 landfill. Tritium in landfills, firing table soils, and ground water are potential sources of diffuse emissions of tritium to the atmosphere at Site 300. LLNL personnel maintain an air tritium sampler at a perimeter location at Site 300, and doses from diffuse tritium sources may be estimated based on the monitoring data for that sampling location. For the calendar year 2001, all measurements in ambient air at the Site 300 perimeter location were below the detection limits of the analytical method, and were consistent with natural background measurements.

Resuspension of Depleted Uranium in Soil at Site 300

Like tritium, depleted uranium has been used as a component of explosives test assemblies. It remains as a residue in surface soils, especially near the firing tables. Because surface soil is subject to resuspension by the action of wind, rain, and other environmental disturbances, the collective effects of surface soil uranium residuals on off-site doses were evaluated.

For the 1995 NESHAPs annual report, we developed calculations to separate the contribution to measured uranium activities from naturally occurring uranium (NU) (Gallegos et al., 1996, Lawrence Livermore National Laboratory, UCRL-ID-113867-96). We base our dose estimate for resuspended depleted uranium (DU) on the measured environmental surveillance monitoring total concentration in air of uranium-238, subtracting out the part contributed by NU, from the following equation:

$$\mu = \frac{0.00726 - 0.99274\dfrac{M(CU-235)}{M(CU-238)}}{0.00526\dfrac{M(CU-235)}{M(CU-238)} + 0.00526}$$

where μ is the fraction (by weight) of uranium contributed by operations, CU is composite uranium (both DU and NU), M(CU-235) the mass of U-235 in the composite (measured) uranium, and M(CU-238) the mass of U-238 in the composite (measured) uranium. (For derivation of the equation see the 1995 NESHAPs annual report, referenced above.)

As explained in last year's Site Annual Environmental Report (*Environmental Report 2000*, Biermann et al. Sept. 2001; Chapter 5, "Results" section, p. 5-7), the glass fiber filter media used in our monitors contain concentrations of ^{235}U that are too high for our approach to reliably determine the quantity of operations-contributed DU. (To correct this deficiency, in January 2002 the sampling media for airborne particulates was changed from glass fibers to cellulose filters.) In absence of a better present approach, we used an eight-year average value of the estimated SW-MEI dose based on this method. This average gave 0.0037 mrem (0.037 μSv) as the dose

attributed to resuspension of DU in soil for 2001. Coincidentally, this is the same as the previous year's (2000) value.

Modeling Dose from Tritium

To evaluate dose from tritium releases to air, we use the EPA-sanctioned CAP88-PC code. Its tritium model calculates dose from inhalation, skin absorption, and ingestion of tritium only in its tritiated water vapor form (HTO). CAP88-PC's tritiium model is based on the specific activity model, which assumes that the tritium-to-hydrogen ratio in body water is the same as in air moisture. Because the specific activity model is linked in CAP88-PC with relatively high dose coefficients for HTO, the model's dose predictions generally err on the high side.

Doses from unit concentration of HT in air are a factor of 15,000 times lower than those from unit concentration of HTO in air (International Commission on Radiological Protection (ICRP), 1995, *Age dependent doses to members of the public from intake of radionuclides, Part 4, Inhalation Dose Coefficients*. Oxford: Pergamon Press; ICRP Publication 71; Ann. ICRP 25[3&4]). Thus, doses from inhaled HT can safely be ignored unless the air concentration is extremely high. A release of HT cannot be ignored, however, because HT that reaches the ground is rapidly and efficiently converted to HTO by microorganisms in soil (McFarlane, Rogers, and Bradley, Environmental Science and Technology 12: 590-593,1978; Brown, Ogram, and Spencer, Health Physics 58:171-181, 1990) and to a lesser extent in vegetation (Sweet and Murphy, Environmental Science and Technology, 18:358-361, 1984).

Organically bound tritium (OBT) is formed by plants during photosynthesis and is incorporated by animals when ingested. Animals also metabolize some OBT from ingested or inhaled HTO. The ICRP dose coefficient for OBT is about 2.3 times higher than that of HTO, because the biological half-life of OBT in the body is longer than that of HTO, which is eliminated at the same rate as body water. Although doses predicted by CAP88-PC are generally high enough to account for dose from ingested OBT, nevertheless, a model that explicitly calculates dose from OBT is preferable.

A simple tritium model, NEWTRIT, has been developed that calculates ingestion dose from both HTO and OBT and accounts for conversion of HT to HTO in the environment after releases of HT (Peterson, S-R. and P.A. Davis, Health Physics 82(2):213-225, 2002). For this report, LLNL has used the NEWTRIT model in CAP88-PC, in addition to the default CAP88-PC code, to estimate doses from significant sources of tritium emissions; see, e.g., Table 3. A brief discussion of the NEWTRIT model was presented in Attachment 2 of last year's NESHAPs annual report (*LLNL NESHAPs 2000 Annual Report*, Gallegos et al. June 2001).

The NEWTRIT model was presented to EPA and DOE at a meeting of the Health Physics Society (Cleveland, OH, June 2001), and the paper was published in that society's journal (Peterson and Davis, 2002, Op. cit.). In October 2001, LLNL sent a letter to EPA Region IX requesting consideration of an alternative methodology for calculating doses from atmospheric releases of tritiated water vapor (HTO) and tritiated gas (HT) for use in demonstrating compliance with radionuclide NESHAPs (40 CFR 61 Subpart H). Copies of NEWTRIT, CAP88-PC-T (CAP88-PC with NEWTRIT encoded as the tritium model), and associated documentation were given to EPA and several DOE laboratories that had expressed interest. A decision has not been made as of this writing, but LLNL is hopeful that NEWTRIT, or a similar approach to modeling releases of HT and HTO for regulatory compliance, will be accepted.

Comparison of 2001 Modeling Results with Tritium Air Surveillance Monitoring Data

A comparison was made between CAP88-PC-predicted concentrations of tritium in air and ambient air monitoring data for the eleven tritiated water vapor samplers on the Livermore site (designated VIS, SALV, POOL, CAFE, MESQ, MET, COW, B331, B514, B624, and B292) and one off-site sampler (ZON7) that have been used for comparison since 1997. Monitor locations are shown in Figure 7.

Only the three most significant sources of tritium releases to air at the Livermore site were included in the model-data comparison. The largest point source is the Tritium Facility (Building 331), where the tritium is emitted from two 30-m-high, continuously monitored stacks. The Building 331 stack emissions were determined independently by stack monitoring, with the result that a total of 18.3 Ci (6.8×10^{11} Bq) of HTO was emitted in 2001. (The 1.7 Ci [6.3×10^{10} Bq] of HT emitted from the Tritium Facility stacks is not included in the comparison because the air tritium samplers only collect HTO.) These stacks make the largest contribution to the concentrations of tritium in most of the monitors, because the emissions are cast high into the air. Diffuse-source emissions are lower to the ground, primarily affecting those monitors in closest proximity. The other two principal sources in our modeling/measurement comparison are of this type: open-air diffuse emission areas associated with the Building 612 Yard and the Tritium Facility (Building 331) outside yard waste accumulation and storage areas. Emissions from the Building 612 Yard source were estimated to be 2.0 Ci (7.4×10^{10} Bq), based on calibrating CAP88PC-predictions of tritium concentrations at the tritium monitor B624 closest to it. (Thus the B624 data do not provide a test of the modeling.) Emissions from the B331 outside yard source were estimated to be 1.0 Ci (3.7×10^{10} Bq) in 2001, based on facility knowledge and environmental monitoring data (primarily the B331 monitor near this yard). While these two diffuse sources contribute significantly to tritium concentrations in all of the monitors, all other potential sources of tritiated water vapor release, such as the

hazardous waste management operations in Building 514 and the Building 292 diffuse source, were too minor to influence the model-data comparison.

Annual average concentrations of HTO in air (pCi/m^3) at the locations of the twelve monitors were modeled for the three sources individually and collectively, and compared to the measured annual median concentrations . The results are displayed in Table 10.

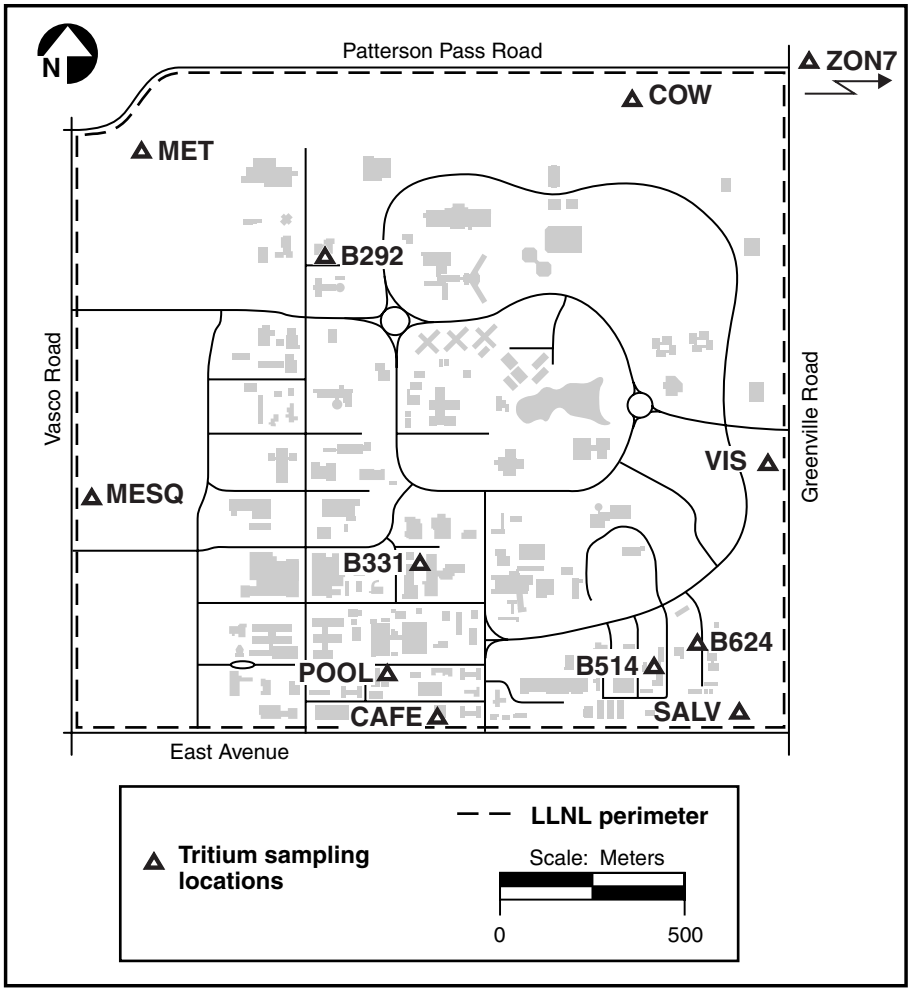

Figure 7. Tritiated water vapor surveillance sampling locations, Livermore site.

The main conclusion shown in Table 10 is that by taking into account the leading sources releasing tritiated water vapor to air, fairly good agreement is obtained with data for all of the monitors. Generally, the modeling results agree with the on-site monitoring data within a factor of 2.5 (at ten out of twelve locations). However, in the case of two monitors (B514 and SALV), the difference is about a factor of four. The under-predictions are not as great as the over-predictions, a desired result since

it is preferable to err on the conservative side of predicting higher values. For the B292 monitor, its under-prediction is likely attributable to our neglect in the modeling of the quite small diffuse source near the building, which would noticeably contribute only to that monitor's value. In 2001, as in the past, CAP88-PC somewhat over-predicts concentrations of tritium in air at the site perimeter and offsite at ZON7.

Table 10. Comparison of measured and modeled annual-average concentrations of tritiated water vapor (HTO) in air at selected Livermore site locations, 2001.

Air monitor location (name)	Measured average concentration (pCi/m^3)	Modeled* average concentration (pCi/m^3)	Ratio of modeled-to-measured concentrations	Modeled concentration of tritium in air contributed by the indicated source (pCi/m^3)		
				B331 Stacks	B612 Yard	B331 Outside
B624	49.1	48.4	0.99	0.31	48	0.075
B331	7.67	13.1	1.7	0.051	0.84	12
B514	4.16	18.2	4.4	0.15	18	0.076
VIS	1.57	1.76	1.1	0.69	0.94	0.13
POOL	2.40	1.90	0.79	0.45	0.75	0.70
CAFE	1.12	1.69	1.5	0.39	0.91	0.39
COW	0.818	0.338	0.41	0.085	0.15	0.10
B292	1.37	0.545	0.40	0.087	0.24	0.22
SALV	0.651	2.55	3.9	0.11	2.4	0.037
MESQ	0.621	0.642	1.0	0.11	0.22	0.31
MET	0.284	0.334	1.2	0.063	0.14	0.13
ZON7	0.378	0.505	1.3	0.38	0.086	0.039
(CRED)**	—	2.39	—	0.74	1.5	0.15

* This result takes into account the three most significant tritium sources; it is the sum of the three contributions shown in the far-right column.

** The CRED location does not have a tritium surveillance air monitor, but is included since it marks the location of the SW-MEI.

Effect on Modeling/Monitoring Comparison of Corrections to Results of Tritium Air Surveillance Monitoring

As noted earlier in Section II, it has been found that LLNL's results for measured concentrations of tritium in ambient air require correction, due to new understanding of the effects of moisture retention by the silica gel prior to sampling. Comparisons between air concentrations predicted by CAP88-PC and observed air tritium concentrations have been included in LLNL's NESHAPs reports since 1997. The comparison shown in Table 10 uses the corrected measured values, but we should revise all comparisons for earlier years, replacing the original measured values by their corrected counterparts. Unfortunately, this is not possible, since there is no way to accurately correct LLNL's measured values obtained prior to January 2001. Two of

several reasons for this inability to correct old data are that (1) the correction factor is different for each batch of silica gel, which was changed from time to time in the past (most recently in May 2000), and (2) the initial dry-weights of the silica gel must be known for the correction factor determination, but these were not recorded and cannot be reconstructed. In lieu of a better alternative, a conservatively high correction factor of 2.1 was chosen to apply to air concentrations measured prior to 2001, to allow for the possibility that the silica gel used in previous years had more bound water than that used presently. (Approximately 99% of the results for 2001 had a correction factor less than or equal to 2.1.)

Using the 2.1 factor, revised predicted-to-observed (P/O) ratios of tritium concentrations in air at Livermore site perimeter locations and ZON7 are compared in Table 11 with the previously published ratios, for comparisons made each of the last four years. Without correction, only two of the thirty-two P/O ratios were less than 1.0, with the lowest being 0.84 at COW in 1997. When the observations are increased by a factor of 2.1, seven P/O ratios are below 1.0, with the lowest being 0.4 at COW in 1997.

Table 11. Previously published (upper) and revised (lower) ratios of predicted-to-observed air concentrations of tritiated water at Livermore site perimeter locations and ZON7, 1997-2000.

Monitor	1997	1998	1999	2000
CAFE	1.9	3.4	6.3	6.1
	0.89	1.6	3.0	2.9
COW	0.84	1.0	1.6	1.0
	0.40	0.49	0.77	0.50
MESQ	3.3	5.6	4.0	5.0
	1.6	2.6	1.9	2.4
MET	3.2	2.4	3.1	2.4
	1.5	1.2	1.5	1.1
POOL	0.99	2.2	3.9	4.4
	0.47	1.1	1.9	2.1
SALV	1.5	6.9	3.7	11.
	0.73	3.3	1.8	5.2
VIS	3.0	2.4	5.7	3.0
	1.4	1.2	2.7	1.4
ZON7	3.9	3.2	5.5	3.0
	1.9	1.5	2.6	1.4

It should be noted that the expected uncertainty in concentrations calculated with a Gaussian plume model (such as used by CAP88-PC) produce a range of values that bracket the dispersion in P/O ratios in Table 11. Limitations of the Gaussian plume model are discussed in general terms in Section 3.2.10 of the AIRDOS-EPA manual (Moore, R.E., et al., "AIRDOS-EPA: A computerized methodology for estimating environmental concentrations and doses to man from airborne releases of radionuclides," Oak Ridge National Laboratory; USDOE Report, ORNL-5532, NTIS; 1979). More specifically, a comparison of AIRDOS-EPA predictions of air concentrations for various radionuclides (^{234}U, ^{238}U, ^{85}Kr, and ^{3}H) with measurements at six different sites concluded that the 90% confidence interval for the accuracy of the CAP88-PC dispersion model ranges from a factor of 0.3 to 4.4, based on 51 samples ("Comparison of AIRDOS-EPA predictions of ground-level airborne radionuclide concentrations to measured values," Jack Faucett Associates, Bethesda, MD. 20814; JACKFAU-341/12-87; 1987).

SECTION IX. Supplemental Information on Compliance

Status of Compliance with Other Regulations

Status of compliance with 40 CFR 61 Subpart Q - National Emission Standards for Radon Emissions from Department of Energy Facilities

LLNL does not have storage and disposal facilities for radium containing materials that would be a significant source of radon.

Status of compliance with 40 CFR 61 Subpart T - National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings

LLNL does not have or store any uranium mill tailings.

Information on Radon-220 and Radon-222 Emissions

Radon emissions occur naturally by emanation from the earth. Radon-222 emissions that were reported in past NESHAPs annual reports from research experiments at the Livermore site did not occur in 2001.

ATTACHMENT 1. LLNL NESHAPs 2001 Annual Report Spreadsheet

Guidance for Interpreting the Data Spreadsheet

A generalized description of each facility and its operations is provided on the spreadsheet. In addition, the following information is shown for each listed emission point or stack:

- Building and room number(s)
- Specific stack identification code(s)
- Generalized description of operations in the room(s) or area(s)
- Radionuclides utilized in the operation
- Annual radionuclide usage inventory with potential for release (by isotope, in curies)
- Physical state factors (by isotope)
- Stack parameters
- Emission control devices and emission control device abatement factors
- Estimated or measured annual emissions (by isotope)
- Distance and direction to the site-wide maximally exposed individual (SW-MEI)
- Calculated EDE to the SW-MEI
- Distance and direction to the maximally exposed individual for that specific source (MEI)
- Calculated EDE to the MEI (source term not adjusted for emission controls)
- Source category

Radionuclides

The radionuclides shown in the spreadsheet are those from specific emission points where air emissions were possible. If radionuclides were present, but encapsulated or sealed for the entire year, radionuclides, annual usage inventories, and emissions are not listed.

Radionuclide Usage Inventories with Potential for Release

The annual radionuclide usage inventories for point source locations are based on data from facility experimenters and managers. For Buildings 251 (hardened area) and 332, classification issues regarding transuranic radionuclide usage inventories make use of the usage inventory/modeling approach impractical. However, all such affected emission points in these buildings are continuously monitored, and emissions are therefore directly determined.

Physical State Factors

The physical state factors listed are EPA potential release fractions from 40 CFR 61, Appendix D, whereby emissions are estimated from radionuclide usage inventories depending on their physical states for use in dispersion/dose assessment modeling. A physical state factor of 1.0×10^{-6} is used for solids, 1.0×10^{-3} is used for liquids and powders, and 1.0 is used for unconfined gases. The U.S. EPA has granted LLNL approved alternative emissions factors for elemental uranium, uranium/niobium alloy, and elemental plutonium. (See Table 2, page 14.) These factors are allowed provided that the material is not intentionally dispersed to the environment and that the processes do not alter the chemical form of the material.

Stack Parameters

Engineering surveys conducted from 1990 through 1992 form the basis for the stack physical parameters shown, which were checked and validated by facility experimenters and managers for 1994 and 1995. Stack physical parameters for sources evaluated in 2001 were updated, as necessary, by experimenters and managers for those facilities.

Emission Control Devices

High Efficiency Particulate Air (HEPA) filters are used in many LLNL facilities to control particulate emissions. For some discharge points, scrubbers and electrostatic precipitators aid the control of emissions. The operational performance of all HEPA filtration systems is routinely tested. The required efficiency of a single stage HEPA filter is 99.97%. Double staged filter systems are in place on some discharge points. Triple stage HEPA filters are used on glove box ventilation systems in the Building 332 Plutonium Facility and in the hardened portion of Building 251.

Control Device Abatement Factors

Similar to physical state factors, control device abatement factors, from Table 1 in 40 CFR 61, Appendix D, are those associated with the listed emission control devices, and are used to better estimate actual emissions for use in dispersion and dose models. By regulation, each HEPA filter stage is given a 0.01 factor (even though the required test efficiency that all LLNL HEPA filters must maintain would yield a factor of 0.0003).

Estimated Annual Emissions

For unmonitored and non-continuously monitored sources, estimated annual emissions for each radionuclide are based on the product of (1) usage inventory data, (2) time factors (discussed in "Emission Source Terms" in Section III, (3) EPA potential release fractions (physical state factors), and (4) applicable emission control device abatement factors.

Actual emission measurements are the basis for reported emissions from continuously monitored facilities. LLNL facilities that had continuous monitoring systems in 2001 were Buildings 175, 177, 235, 251, 331, 332, and 491, as noted earlier. See the discussion below under "0.1 mrem/y Monitoring Requirement" regarding the use of emissions measurements for monitored sources.

10 mrem/y Site-Wide Dose Requirement

For LLNL to comply with the NESHAPs regulations, the LLNL site-wide maximally exposed individual (SW-MEI; defined as the hypothetical member of the public at a single residence, school, business, or office who receives the greatest LLNL-induced EDE from the combination of all radionuclide source emissions) cannot receive an EDE greater than 10 mrem/y (100 μSv/y). (See Section II for a discussion of the SW-MEI.)

In Attachment 1, the distance and direction to the respective SW-MEI are shown for each facility at each site. Doses to the site specific SW-MEIs were evaluated for each source and then totaled for site specific evaluations against the 10 mrem/y dose standard (see "Total Dose Estimate" in Section IV).

0.1 mrem/y Monitoring Requirement

To assess compliance with the requirement for continuous monitoring (potential dose greater than 0.1 mrem/y [1.0 μSv/y] to the maximally-exposed public individual or MEI, discussed earlier in Section II), emissions must be individually evaluated from each point source. The location of the MEI is generally different for each emission point. The maximum dose at a location of unrestricted public access typically occurs at a point on the site perimeter. Therefore, it is often referred to as the maximum "fence line" dose, although the off-site maximum dose could occur some distance beyond the perimeter. (This could happen, e.g., when the perimeter is close to a stack; however, for nearly all emission points at the Livermore site and Site 300, calculations show that ground level concentrations of radionuclides generally decline continuously beyond LLNL boundaries.) As stipulated by the regulations, modeling for assessment of continuous monitoring requirements assumed unabated emissions (i.e., no credit was taken for emission abatement devices, such as filters), but physical state factors and time factors were applied.

The unabated EDE cannot be calculated for HEPA-filtered facilities monitored for radioactive particles. Because the monitoring equipment is placed after HEPA filtration, there is no way to obtain an estimate for what the emissions might have been had there been no filtration. It is not reasonable to apply factors for the effects of the HEPA filters on the emission rate because most of what is measured on the HEPA filters is the result of the radioactive decay of radon, which is capable of penetrating the filter. Attachment 1 gives, for each inventoried point source, the

dose to the MEI and the distance and direction to the LLNL fence line where the MEI is located. However, for HEPA-filtered monitored sources, no value is shown.

Source Categories

LLNL radionuclide air emission sources have been classified into seven source categories, indicated by the number in the next to last column of the spreadsheet: (1) Unmonitored or non-continuously monitored Livermore-site facilities that have had a radionuclide usage inventory update for 2001; (2) Unmonitored or non-continuously monitored Livermore site facilities with a previous radionuclide usage inventory update (this category is not used in years with complete usage inventory updates, such as 2000); (3) Continuously monitored Livermore site facilities; (4) Site 300 explosives experiments; (5) Diffuse sources where emissions and subsequent doses were estimated using inventory processes; (6) Diffuse sources where emission and dose estimates were supported by environmental surveillance measurements; and (7) Sources whose emissions estimates and subsequent doses were estimated by confirmatory air sampling rather than continuous sampling.

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
NOTE: CAP88-PC requires activity rates of curies/year and gives doses in mrem/year. To convert curies to becquerels use 1 Ci=3.7E+10 Bq and to convert millirem to sieverts use 1 Sv=1.0E+05 mrem.																			
LIVERMORE SITE POINT SOURCES																			
Building 131 complex is a large office/laboratory facility housing both Mechanical and Electrical Engineering Divisions.																			
131	1221	FFE-02	Storage and cleaning of assemblies	U-238	6.1E-06	1.0E-06	12.2	0.15	7.8	HEPA	0.01	6.1E-14	1326	E	3.1E-12	567	WNW	1.4E-09	2
				U-235	7.9E-08	1.0E-06						7.9E-16							
				U-234	5.7E-07	1.0E-06						5.7E-15							
131	1248	Room Air	Storage and display of post-test materials	U-238	1.5E-06	1.0E-06	NA	NA	NA	None	1	1.5E-12	1326	E	8.6E-11	524	W	1.4E-09	2
				U-235	2.0E-08	1.0E-06						2.0E-14							
				U-234	1.4E-07	1.0E-06						1.4E-13							
131	1248A	Room Air	Storage and display of post-test materials	U-238	7.7E-07	1.0E-06	NA	NA	NA	None	1	7.7E-13	1326	E	4.3E-11	524	W	6.9E-10	2
				U-235	9.9E-09	1.0E-06						9.9E-15							
				U-234	7.2E-08	1.0E-06						7.2E-14							
Building 132 provides office and laboratory space for a range of activities, including the Directorate Offices for Chemistry and Materials Sciences; laboratories in the Analytical & Nuclear Chemistry Division and Chemistry and Chemical Engineering Division; and NAI Directorate Forensic Sciences Center offices and laboratories.																			
132N	2671	FHE-6000/7000	Mass spectrometry analysis	Pu-238	6.1E-07	1.0E-06	38.1	2.13	11.3	Double HEPA	0.0001	6.1E-17	1504	E	2.8E-15	1918	NE	3.8E-11	1
				Pu-239	4.5E-08	1.0E-06						4.5E-18							
				Pu-240	1.1E-08	1.0E-06						1.1E-18							
				Pu-241	1.1E-07	1.0E-06						1.1E-17							
				Pu-242	1.4E-12	1.0E-06						1.4E-22							
				Am-241	1.1E-09	1.0E-06						1.1E-19							
				U-234	6.1E-12	1.0E-06						6.1E-22							
132N	2675	FHE-6000/7000	Preparation of aqueous solutions for analysis	U-234	2.6E-18	1.0E-03	38.1	2.13	8.6	None	1	2.6E-21	1504	E	6.7E-16	481	SW	1.0E-15	2
				U-235	3.3E-16	1.0E-03						3.3E-19							
				U-238	4.6E-14	1.0E-03						4.6E-17							
		FHE-6000/7000	Analysis of aqueous solutions	U-234	1.3E-14	1.0E+00	38.1	2.13	8.6	HEPA	0.01	1.3E-16	1504	E	3.3E-11	481	SW	5.2E-09	2
				U-235	1.7E-12	1.0E+00						1.7E-14							
				U-238	2.3E-10	1.0E+00						2.3E-12							
132N	2679	FHE-6000/7000	Preparation of aqueous solutions for analysis	U-234	3.7E-17	1.0E+00	38.1	2.13	8.6	HEPA	0.01	3.7E-19	1504	E	1.3E-12	481	SW	2.0E-10	2
				U-235	1.5E-14	1.0E+00						1.5E-16							
				U-238	7.4E-12	1.0E+00						7.4E-14							
				Th-232	5.5E-13	1.0E+00						5.5E-15							
132N	2685	FHE-6000/7000	Transfer and solvent extraction of waste samples for PCB analysis	Cs-137	8.8E-09	1.0E-03	38.1	2.13	8.6	None	1	9.0E-12	1504	E	3.8E-11	481	SW	6.2E-11	2
				Co-60	4.4E-10	1.0E-03						4.5E-13							
				Sr-90	4.8E-09	1.0E-03						4.9E-12							
				Th-228	3.4E-13	1.0E-03						3.5E-16							
				Th-230	1.0E-12	1.0E-03						1.0E-15							
				Th-232	7.2E-14	1.0E-03						7.4E-17							
				Pu-238	1.0E-11	1.0E-03						1.1E-14							
				Pu-239	4.4E-10	1.0E-03						4.5E-13							
				Pu-240	2.7E-10	1.0E-03						2.8E-13							
				Pu-241	2.4E-10	1.0E-03						2.5E-13							
				Am-241	2.4E-11	1.0E-03						2.5E-14							
				U-234	6.8E-12	1.0E-03						7.0E-15							
				U-235	3.9E-13	1.0E-03						4.0E-16							
				U-238	1.2E-12	1.0E-03						1.2E-15							
132N	2694	FHE-6000/7000	Transfer and solvent extraction of waste samples for volatiles analysis	Cs-137	5.7E-09	1.0E-03	38.1	2.13	8.6	None	1	5.7E-12	1504	E	2.5E-11	481	SW	3.9E-11	2
				Co-60	2.7E-10	1.0E-03						2.7E-13							
				Sr-90	3.0E-09	1.0E-03						3.0E-12							
				Th-228	2.2E-13	1.0E-03						2.2E-16							
				Th-230	6.5E-13	1.0E-03						6.5E-16							
				Th-232	4.4E-14	1.0E-03						4.4E-17							
				Pu-238	6.5E-12	1.0E-03						6.5E-15							
				Pu-239	2.9E-10	1.0E-03						2.9E-13							
				Pu-240	1.8E-10	1.0E-03						1.8E-13							
				Pu-241	1.5E-10	1.0E-03						1.5E-13							
				Am-241	1.5E-11	1.0E-03						1.5E-14							
				U-234	4.3E-12	1.0E-03						4.3E-15							
				U-235	2.5E-13	1.0E-03						2.5E-16							
				U-238	7.8E-13	1.0E-03						7.8E-16							

Attachment 1 - 2001 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
132N	2870	FHE-6000/7000	Preparation of uranium sol-gels	U-234	4.0E-07	1.0E-03	38.1	2.13	8.6	None	1	4.0E-10	1504	E	1.0E-04	481	SW	1.5E-04	2
				U-235	5.0E-05	1.0E-03						5.0E-08							
				U-238	6.9E-03	1.0E-03						6.9E-06							
132S	2788	FHE-6000/7000	Transfer of uranium	U-238	5.7E-10	1.0E-03	4.6	1.22	8.9	None	1	5.7E-13	1504	E	2.1E-11	453	SW	7.4E-11	2
				U-235	7.3E-12	1.0E-03						7.3E-15							
				U-234	5.3E-11	1.0E-03						5.3E-14							
Building 151 houses the Isotope Sciences Division which applies nuclear and isotope sciences to a wide range of problems, including stockpile stewardship, nonproliferation, safeguard technologies, forensic science, and waste characterization and analysis.																			
Building 151 also contains the Chemistry and Materials Sciences Environmental Services laboratory where samples of waste streams and environmental media (air, water, soil etc.) are analyzed for their radionuclide content.																			
151	1033	FHE-2	Evaporation and transfer of solutions	Cm-248	3.5E-07	1.0E-03	12.8	0.41	7.8	None	1	3.5E-10	1308	E	4.4E-07	768	SW	1.1E-06	2
				Cm-246	8.3E-07	1.0E-03						8.3E-10							
				U-233	1.9E-09	1.0E-03						1.9E-12							
				Np-237	3.5E-08	1.0E-03						3.5E-11							
				Pu-244	1.8E-11	1.0E-03						1.8E-14							
151	1034B	FGBE-5/6	Sample preparation	Am-241	2.7E-04	1.0E-03	7.0	0.13	3.7	Double HEPA	0.0001	2.7E-11	1308	E	1.5E-07	540	W	1.3E-02	1
				Pu-238	3.0E-03	1.0E-03						3.0E-10				584	NWN	1.3E-02	
				Pu-239	4.7E-03	1.0E-03						4.7E-10							
				Pu-240	1.0E-03	1.0E-03						1.0E-10							
				Pu-241	1.6E-02	1.0E-03						1.6E-09							
				Pu-242	4.7E-09	1.0E-03						4.7E-16							
				U-234	3.3E-08	1.0E-03						3.3E-15							
				Am-243	1.4E-04	1.0E-03						1.4E-11							
151	1039	FHE-43	Transfer of solutions	Cs-137	4.6E-10	1.0E-03	12.8	0.46	11.3	None	1	4.6E-13	1308	E	3.9E-11	768	SW	7.6E-11	2
				Sr-90	3.0E-10	1.0E-03						3.0E-13							
				Gross alpha	3.2E-10	1.0E-03						3.2E-13							
151	1123	FHE-41	Evaporation and transfer of solutions	Pu-239	2.5E-14	1.0E-03	12.8	0.30	6.6	None	1	2.5E-17	1308	E	3.5E-15	768	SW	1.0E-14	2
				U-238	2.6E-15	1.0E-03						2.6E-18				584	WNW	1.0E-14	
151	1241	FHE-68	Sample preparation and radiochemical analysis of uranium	U-234	2.5E-05	1.0E-03	13.1	0.30	6.6	None	1	2.5E-08	1308	E	1.4E-06	584	WNW	9.8E-04	1
				U-235	4.2E-07	1.0E-03						4.2E-10							
				U-236	1.2E-06	1.0E-03						1.2E-09							
				U-238	9.3E-09	1.0E-03						9.3E-12							
151	1303	FHE-2000	Sample preparation and analysis (ICP-MS)	U-238	8.4E-13	1.0E+00	11.9	0.48	15.4	None	1	8.4E-13	1308	E	4.4E-08	1125	NNE	8.2E-08	2
				U-235	3.9E-14	1.0E+00						3.9E-14							
				U-234	8.4E-13	1.0E+00						8.4E-13							
				U-233	1.9E-10	1.0E+00						1.9E-10							
				Pu-239	3.1E-10	1.0E+00						3.1E-10							
				U-238	8.4E-14	1.0E-03						8.4E-17							
				U-235	3.9E-15	1.0E-03						3.9E-18							
				U-234	8.4E-14	1.0E-03						8.4E-17							
				U-233	1.9E-11	1.0E-03						1.9E-14							
				Pu-239	3.1E-11	1.0E-03						3.1E-14							
151	1304	FHE-2000	Sample preparation	Gross alpha	1.2E-08	1.0E-03	11.9	0.48	15.4	None	1	1.2E-11	1308	E	1.5E-09	1125	NNE	2.6E-09	1
				Gross beta	2.0E-08	1.0E-03						2.0E-11							
				Gross gamma	2.0E-08	1.0E-03						2.0E-11							
151	1318	FHE-26	Sample preparation	Pu-239	1.0E-09	1.0E-03	13.1	0.36	7.4	None	1	1.0E-12	1308	E	1.8E-10	768	SW	4.8E-10	2
				Am-241	2.0E-10	1.0E-03						2.0E-13							
				Cm-244	1.0E-10	1.0E-03						1.0E-13							
151	1322	FHE-33	Sample preparation	Gross alpha	6.0E-08	1.0E-03	12.8	0.36	8.1	None	1	6.0E-11	1308	E	1.2E-05	768	SW	3.1E-05	2
				Gross beta	1.0E-07	1.0E-03						1.0E-10							
				Gross gamma	1.0E-07	1.0E-03						1.0E-10							
				U-238	2.4E-04	1.0E-03						2.4E-07							
				U-235	3.1E-06	1.0E-03						3.1E-09							
				U-234	2.2E-05	1.0E-03						2.2E-08							
151	1326	FHE-43	Sample preparation	MFP	5.0E-05	1.0E-03	12.8	0.36	6.8	None	1	5.0E-08	1308	E	7.6E-08	768	SW	2.0E-07	2
				Zn-65	1.0E-07	1.0E-03						1.0E-10							
				Cs-137	2.0E-08	1.0E-03						2.0E-11							
				Cs-134	1.0E-08	1.0E-03						1.0E-11							
				Co-60	2.7E-07	1.0E-03						2.7E-10							
				Bi-207	2.0E-07	1.0E-03						2.0E-10							
				Na-22	2.7E-07	1.0E-03						2.7E-10							
				Eu-152	2.7E-09	1.0E-03						2.7E-12							
				Eu-154	2.7E-09	1.0E-03						2.7E-12							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
151	1326	(continued)		Pu-236	1.0E-06	1.0E-06						1.0E-12							
				Pu-238	1.0E-05	1.0E-06						1.0E-11							
				Pu-239	1.0E-05	1.0E-06						1.0E-11							
				Pu-240	1.0E-05	1.0E-06						1.0E-11							
				Pu-242	1.0E-05	1.0E-06						1.0E-11							
				Pu-244	1.0E-05	1.0E-06						1.0E-11							
				Pu-241	1.0E-04	1.0E-06						1.0E-10							
				Am-241	5.0E-06	1.0E-06						5.0E-12							
				Am-243	5.0E-06	1.0E-06						5.0E-12							
				U-238	6.5E-08	1.0E-06						6.5E-14							
				U-235	3.0E-09	1.0E-06						3.0E-15							
				U-234	4.7E-08	1.0E-06						4.7E-14							
				Np-237	1.0E-07	1.0E-06						1.0E-13							
				Th-232	2.2E-09	1.0E-06						2.2E-15							
				Cf-249	1.0E-06	1.0E-06						1.0E-12							
				Cm-242	1.0E-06	1.0E-06						1.0E-12							
				Cm-244	1.0E-06	1.0E-06						1.0E-12							
				Cm-246	1.0E-06	1.0E-06						1.0E-12							
				Cm-248	1.0E-06	1.0E-06						1.0E-12							
151	1330	FHE-52	Transfer of waste samples for analysis	Cs-137	9.6E-08	1.0E-03	12.8	0.36	7.6	None	1	9.6E-11	1308	E	1.2E-09	768	SW	3.3E-09	2
				Co-60	4.7E-09	1.0E-03						4.7E-12							
				Sr-90	5.2E-08	1.0E-03						5.2E-11							
				Th-228	3.7E-12	1.0E-03						3.7E-15							
				Th-230	1.1E-11	1.0E-03						1.1E-14							
				Th-232	7.7E-13	1.0E-03						7.7E-16							
				Pu-238	1.1E-10	1.0E-03						1.1E-13							
				Pu-239	5.0E-09	1.0E-03						5.0E-12							
				Pu-240	3.0E-09	1.0E-03						3.0E-12							
				Pu-241	2.6E-09	1.0E-03						2.6E-12							
				Am-241	2.6E-10	1.0E-03						2.6E-13							
				U-234	7.4E-11	1.0E-03						7.4E-14							
				U-235	4.3E-12	1.0E-03						4.3E-15							
				U-238	1.3E-11	1.0E-03						1.3E-14							
				H-3	8.4E-12	1.0E-03						8.4E-15							
151	2103	FHE-6	Sorption studies	Pu-239	1.4E-07	1.0E-03	12.8	0.41	7.5	None	1	1.4E-10	1308	E	2.5E-08	768	SW	6.5E-08	2
				Pu-240	3.1E-08	1.0E-03						3.1E-11							
				Pu-241	4.8E-07	1.0E-03						4.8E-10							
				Am-241	8.4E-09	1.0E-03						8.4E-12							
				Pu-238	4.0E-09	1.0E-03						4.0E-12							
151	2107	FHE-14	Transfer of solutions for analysis	Pu-239	2.0E-13	1.0E-03	12.8	0.41	7.3	None	1	2.0E-16	1308	E	3.8E-07	768	SW	9.8E-07	2
				U-238	4.7E-06	1.0E-03						4.7E-09							
				U-235	2.2E-07	1.0E-03						2.2E-10							
				U-234	3.4E-06	1.0E-03						3.4E-09							
151	2109	FHE-19	Collection of daughter products of Th-228	Th-228	1.2E-10	1.0E-06	13.1	0.30	6.1	None	1	1.2E-16	1308	E	1.0E-14	584	WNW	3.0E-14	2
151	2109	FHE-15	Ion exchange studies	Sn-113	1.8E-08	1.0E-03	13.1	0.30	6.2	None	1	1.8E-11	1308	E	8.8E-13	584	WNW	2.5E-12	2
151	2117	FHE-23	Preparation of waste samples for analysis	Gross alpha	9.8E-09	1.0E-03	12.8	0.41	8.0	None	1	9.8E-12	1308	E	1.3E-09	768	SW	3.2E-09	2
				Gross beta	2.2E-10	1.0E-03						2.2E-13							
151	2121	FHE-36	Sample preparation	Cs-137	9.5E-07	1.0E-03	12.8	0.41	8.0	None	1	9.5E-10	1308	E	1.5E-08	768	SW	3.8E-08	2
				Co-60	4.7E-08	1.0E-03						4.7E-11							
				Sr-90	5.1E-07	1.0E-03						5.1E-10							
				Th-228	3.7E-11	1.0E-03						3.7E-14							
				Th-230	1.1E-10	1.0E-03						1.1E-13							
				Th-232	7.6E-12	1.0E-03						7.6E-15							
				Pu-238	1.1E-09	1.0E-03						1.1E-12							
				Pu-239	4.9E-08	1.0E-03						4.9E-11							
				Pu-240	2.9E-08	1.0E-03						2.9E-11							
				Pu-241	2.6E-08	1.0E-03						2.6E-11							
				Am-241	2.6E-09	1.0E-03						2.6E-12							
				U-234	7.3E-10	1.0E-03						7.3E-13							
				U-235	4.3E-11	1.0E-03						4.3E-14							
				U-238	1.3E-10	1.0E-03						1.3E-13							
				Pu-239	2.4E-08	1.0E-03						2.4E-11							
				Sr-90	4.9E-10	1.0E-03						4.9E-13							
				H-3	7.3E-08	1.0E-03						7.3E-11							

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	10 mrem/y Site-Wide Dose Requirement: Direction to SWMEI	10 mrem/y Site-Wide Dose Requirement: EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	0.1 mrem/y Monitoring Requirement: Direction to MEI	0.1 mrem/y Monitoring Requirement: Unabated EDE (mrem)	Source Category
151	2131	FHE-47	Transfer and processing of ground water samples for radiochemical analysis	Gross gamma	5.0E-09	1.0E-03	12.8	0.41	7.8	None	1	5.0E-12	1308	E	2.3E-12	584	WNW	4.5E-12	1
				Gross alpha	2.5E-13	1.0E-03						2.5E-16							
151	2131	FHE-56	Transfer and processing of glass samples for radiochemical analysis	Gross gamma	6.8E-12	1.0E-06	12.8	0.41	7.3	None	1	6.8E-18	1308	E	4.6E-15	584	WNW	9.1E-15	1
				Gross alpha	3.4E-11	1.0E-06						3.4E-17							
151	2133	FHE-57	Swipe sample analysis	Gross alpha	1.4E-14	1.0E-03	12.8	0.41	8.1	None	1	1.4E-17	1308	E	1.8E-15	768	SW	4.5E-15	2
151	2143	FHE-63	Transfer of standards for the analysis of environmental samples; analysis of standards for environmental samples	H-3	3.6E-12	1.0E-03	12.8	0.41	8.2	None	1	3.6E-15	1308	E	8.7E-19	768	SW	2.1E-18	2
151	2147	FHE-67	Transfer of yield tracers for	Pu-242	7.1E-13	1.0E-03	12.8	0.41	8.0	None	1	7.1E-16	1308	E	6.5E-14	768	SW	1.6E-13	2
151	2149	FHE-78	Transfer of yield tracers samples as yield tracers during analysis	Pu-238	2.0E-14	1.0E-03	13.1	0.41	7.8	None	1	2.0E-17	1308	E	6.0E-13	768	SW	1.5E-12	2
				Pu-239	4.0E-14	1.0E-03						4.0E-17							
				Pu-240	4.0E-14	1.0E-03						4.0E-17							
				Pu-242	3.0E-12	1.0E-03						3.0E-15							
				U-232	1.0E-12	1.0E-03						1.0E-15							
				U-233	9.0E-13	1.0E-03						9.0E-16							
				U-238	4.0E-15	1.0E-03						4.0E-18							
				Cs-134	1.4E-12	1.0E-03						1.4E-15							
				Cs-137	8.1E-13	1.0E-03						8.1E-16							
151	2302A	FHE-9	Waste treatability studies	H-3	1.0E-04	1.0E-03	13.1	0.41	7.5	None	1	1.0E-07	1308	E	2.1E-11	768	SW	5.9E-11	2
				U-235	6.1E-14	1.0E-03						6.1E-17							
151	2308	FHE-16	Ceramics leaching studies	Pu-239	1.9E-02	1.0E-03	12.8	0.41	7.3	Double HEPA	0.0001	1.9E-09	1308	E	3.5E-07	768	SW	8.9E-03	2
				Pu-240	4.2E-03	1.0E-03						4.2E-10							
				Pu-241	6.8E-02	1.0E-03						6.8E-09							
				Am-241	1.1E-03	1.0E-03						1.1E-10							
				Pu-238	5.6E-04	1.0E-03						5.6E-11							
				U-234	2.2E-07	1.0E-03						2.2E-14							
				U-235	9.7E-09	1.0E-03						9.7E-16							
				U-238	2.1E-07	1.0E-03						2.1E-14							
151	2308	FHE-12	Ceramics leaching studies	U-234	6.6E-07	1.0E-03	13.1	0.41	7.8	None	1	6.6E-10	1308	E	5.9E-08	768	SW	1.4E-07	2
				U-235	2.9E-08	1.0E-03						2.9E-11							
				U-238	6.1E-07	1.0E-03						6.1E-10							
151	2312	FHE-21	Solubility studies	Np-237	2.7E-08	1.0E-03	12.8	0.41	7.6	Double HEPA	0.0001	2.7E-15	1308	E	4.9E-13	768	SW	1.2E-08	2
151	2312	FHE-21	Solubility studies	Np-237	6.4E-09	1.0E-03	12.8	0.41	7.1	None	1	6.4E-12	1308	E	1.2E-09	768	SW	3.0E-09	2
151	2318	FHE-22	Transfer of sample solutions	Pu-242	1.9E-09	1.0E-03	9.8	0.41	8.0	Double HEPA	0.0001	1.9E-16	1308	E	2.5E-14	768	SW	7.8E-10	2
151	2322	FHE-38	Transfer and processing of of waste sludge samples for TCLP, STLC, pH, % moisture, TTLC analyses	Cs-137	3.4E-07	1.0E-03	12.8	0.41	8.1	None	1	3.4E-10	1308	E	5.6E-09	768	SW	1.4E-08	2
				Co-60	1.7E-08	1.0E-03						1.7E-11							
				Sr-90	1.8E-07	1.0E-03						1.8E-10							
				Th-228	1.3E-11	1.0E-03						1.3E-14							
				Th-230	3.9E-11	1.0E-03						3.9E-14							
				Th-232	2.8E-12	1.0E-03						2.8E-15							
				Pu-238	3.9E-10	1.0E-03						3.9E-13							
				Pu-239	1.8E-08	1.0E-03						1.8E-11							
				Pu-240	1.1E-08	1.0E-03						1.1E-11							
				Pu-241	9.4E-09	1.0E-03						9.4E-12							
				Am-241	9.4E-10	1.0E-03						9.4E-13							
				U-234	2.6E-10	1.0E-03						2.6E-13							
				U-235	1.5E-11	1.0E-03						1.5E-14							
				U-238	4.7E-11	1.0E-03						4.7E-14							
				Gross alpha	9.0E-09	1.0E-03						9.0E-12							
				Gross beta	2.1E-10	1.0E-03						2.1E-13							
				H-3	2.1E-08	1.0E-03						2.1E-11							
151	2326	FHE-39	Chemical analysis of waste	Cs-137	3.8E-07	1.0E+00	12.8	0.41	7.6	None	1	3.8E-07	1308	E	8.8E-06	768	SW	2.2E-05	2
				Co-60	1.8E-08	1.0E+00						1.8E-08							
				Sr-90	2.0E-07	1.0E+00						2.0E-07							
				Th-228	1.5E-11	1.0E+00						1.5E-11							
				Th-230	4.3E-11	1.0E+00						4.3E-11							
				Th-232	3.0E-12	1.0E+00						3.0E-12							
				Pu-238	4.4E-10	1.0E+00						4.4E-10							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	10 mrem/y Site-Wide Dose Requirement: Direction to SWMEI	10 mrem/y Site-Wide Dose Requirement: EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	0.1 mrem/y Monitoring Requirement: Direction to MEI	0.1 mrem/y Monitoring Requirement: Unabated EDE (mrem)	Source Category
151	2326	(continued)		Pu-239	2.0E-08	1.0E+00						2.0E-08							
				Pu-240	1.2E-08	1.0E+00						1.2E-08							
				Pu-241	1.0E-08	1.0E+00						1.0E-08							
				Am-241	1.0E-09	1.0E+00						1.0E-09							
				U-234	2.9E-10	1.0E+00						2.9E-10							
				U-235	1.7E-11	1.0E+00						1.7E-11							
				U-238	5.2E-11	1.0E+00						5.2E-11							
				Gross alpha	3.0E-08	1.0E+00						3.0E-08							
				Gross beta	6.0E-10	1.0E+00						6.0E-10							
				H-3	9.0E-08	1.0E+00						9.0E-08							
151	2326A	FHE-40	Preparation of environmental and waste samples	Gross alpha	1.0E-09	1.0E-03	12.8	0.30	3.9	None	1	1.0E-12	1308	E	1.4E-10	584	WNW	5.4E-10	2
151	2330	FHE-50	Analysis of standards for waste samples; analysis of waste samples	Pu-239	3.9E-09	1.0E-03	12.8	0.41	7.5	None	1	3.9E-12	1308	E	5.1E-10	768	SW	1.3E-09	2
				H-3	5.7E-12	1.0E-03						5.7E-15							
				H-3	9.0E-09	1.0E+00						9.0E-09							
151	2348	FHE-75	Freeze trapping/analysis of tritium	H-3	1.5E-13	1.0E+00	12.8	0.41	8.7	None	1	1.5E-13	1308	E	3.7E-17	768	SW	8.7E-17	2
				H-3	3.6E-12	1.0E-03						3.6E-15							
151	2350	FHE-76	Transfer of tracer solutions	Pu-242	1.2E-12	1.0E-03	12.8	0.41	8.4	None	1	1.2E-15	1308	E	4.6E-13	768	SW	1.1E-12	2
				Am-243	5.7E-13	1.0E-03						5.7E-16							
				U-232	3.3E-13	1.0E-03						3.3E-16							
				Pu-239	7.3E-13	1.0E-03						7.3E-16							
				Am-241	8.6E-14	1.0E-03						8.6E-17							
				U-234	6.8E-11	1.0E-03						6.8E-14							
				U-235	8.5E-09	1.0E-03						8.5E-12							
				U-238	1.2E-06	1.0E-03						1.2E-09							
Buildings 175 and 177 were part of the Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program, affiliated with The United States Enrichment Corporation (USEC). In June 1999, USEC suspended further development of the U-AVLIS technology.																			
*Gross alpha and Gross beta emissions are continuously monitored at the stack. Monitoring data, rather than the inventory approach, are used to determine emissions.																			
**Because monitoring takes place after HEPA filtration, an unabated EDE cannot be determined (see discussion on page 38.)																			
175	103	FFE-02	Operations discontinued	Gross alpha	*	NA	9.4	0.61	4.5	HEPA	1.0E-02	0.0E+00	**	**	0.0E+00	**	**	**	3
	103	FFE-01		Gross beta	*	NA	9.4	0.61	4.6			0.0E+00							
	112	FHE-02					6.8	0.36	6.4										
	112	FHE-01					6.7	0.33	6.4										
	128	FHE-2000					8.9	0.59	4.6										
	128	FHE-1000					8.9	0.59	5.2										
177	1020	FHE-22	Operations discontinued	Gross alpha	*	NA	6.4	0.30	8.9	HEPA	0.01	0.0E+00	**	**	0.0E+00	**	**	**	3
				Gross beta	*	NA						0.0E+00							
Building 194 is operated by N-Division for the Physics and Space Technology Directorate. The facility houses a high-energy linear accelerator (LINAC) and research laboratories.																			
The accelerator beam can produce small quantities of short-lived air activation products.																			
194	B122	TE-FE4	Linac accelerator vault	O-15	6.0E-02	1.0E+00	30.5	1.37	4.5	None	1	6.0E-02	1525	SSE	5.2E-07	538	NE	5.3E-05	2
		(Target Exhaust)		N-13	1.1E-01	1.0E+00						1.1E-01							
194	B124	TE-FE4	Storage	Na-22	5.0E-05	1.0E-03	30.5	1.37	4.5	None	1	5.0E-08	1525	SSE	9.7E-09	538	NE	1.4E-07	2
				U-233	1.2E-05	1.0E-06						1.2E-11							
				U-234	6.0E-09	1.0E-06						6.0E-15							
				U-235	3.9E-06	1.0E-06						3.9E-12							
				U-236	3.5E-08	1.0E-06						3.5E-14							
				U-238	1.0E-04	1.0E-06						1.0E-10							
194	B130	TE-FE4	Positron beam generation	O-15	5.5E-01	1.0E+00	30.5	1.37	4.5	None	1	5.5E-01	1525	SSE	5.2E-06	538	NE	5.2E-04	2
				N-13	1.1E+00	1.0E+00						1.1E+00							
194	1131	Room Air	Positron materials science experiments	Na-22	3.6E-06	1.0E-03	NA	NA	NA	None	1	3.6E-09	1525	ESE	2.4E-09	532	W	7.0E-08	2
Building 212 is administered by the Physics and Space Technology Directorate (formerly the Physical Sciences Directorate) for miscellaneous physics experiments.																			
The current radionuclide emissions are due to contamination from past operations of the rotating target neutron source, which is no longer in operation.																			
212	174	FHE-7	Contamination	H-3	1.7E-02	1.0E-06	4.3	0.5	0.5	None	1	1.7E-08	1278	ENE	8.5E-12	38	SW	3.4E-10	2
212	184	Room Air	Contamination	H-3	1.0E-03	1.0E-06	NA	NA	NA	None	1	1.0E-09	1278	ENE	5.0E-13	38	SW	2.2E-11	2

Attachment 1 - 2001 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
The 231 complex houses research and development activities conducted by the Chemistry and Materials Science Directorate, Engineering, Weapons Engineering, and Safeguards and Security Materials Management Division.																			
Management oversight for Building 231 is provided by the Engineering Directorate through the Engineering Sciences Division.																			
231	1000	FFE-5	Metal casting	U-238	2.6E-07	1.0E-06	8.2	0.32	7.7	HEPA	0.01	2.6E-15	1167	E	1.7E-11	671	W	6.8E-11	2
				U-235	3.3E-09	1.0E-06						3.3E-17							
				U-234	2.4E-08	1.0E-06						2.4E-16							
231	1427	Room Air	Wet grinding/lapping	U-238	3.1E-07	1.0E-06	NA	NA	NA	None	1	3.1E-13	1167	E	4.3E-11	671	W	3.6E-10	2
				U-235	1.5E-08	1.0E-06						1.5E-14							
				U-234	3.3E-07	1.0E-06						3.3E-13							
231	1600	Room Air	Friction test on solid	U-238	1.5E-03	1.0E-06	NA	NA	NA	None	1	1.5E-09	1167	E	1.1E-07	671	W	8.8E-07	2
			depleted uranium bars	U-235	1.9E-02	1.0E-06						1.9E-08							
				U-234	1.4E-01	1.0E-06						1.4E-07							
231	1640	Room Air	Mechanical test; quasistatic	U-238	5.9E-09	1.0E-06	NA	NA	NA	None	1	5.9E-15	1167	E	4.1E-13	671	W	3.4E-12	2
			compression	U-235	7.6E-11	1.0E-06						7.6E-17							
				U-234	5.5E-10	1.0E-06						5.5E-16							
231	1678	Room Air	Mechanical test; compression	U-238	6.8E-09	1.0E-06	NA	NA	NA	None	1	6.8E-15	1167	E	4.7E-13	671	W	3.9E-12	2
			Hopkinson bar (U6Nb)	U-235	8.7E-11	1.0E-06						8.7E-17							
				U-234	6.3E-10	1.0E-06						6.3E-16							
231	1737	FGBE-5	Electron beam welding	U-238	1.5E-06	1.0E-06	10.1	0.46	1.5	HEPA	0.01	1.5E-14	1167	E	1.0E-12	671	W	5.6E-10	2
				U-235	1.9E-08	1.0E-06						1.9E-16							
				U-234	1.4E-07	1.0E-06						1.4E-15							
				U-238	8.1E-11	1.0E-03						8.1E-16							
				U-235	1.0E-12	1.0E-03						1.0E-17							
				U-234	7.5E-12	1.0E-03						7.5E-17							
231	1737A	FHE-54	Electron beam welding	U-238	1.5E-06	1.0E-06	10.1	0.46	1.5	HEPA	0.01	1.5E-14	1167	E	1.0E-12	671	W	5.6E-10	2
				U-235	1.9E-08	1.0E-06						1.9E-16							
				U-234	1.4E-07	1.0E-06						1.4E-15							
				U-238	8.1E-11	1.0E-03						8.1E-16							
				U-235	1.0E-12	1.0E-03						1.0E-17							
				U-234	7.5E-12	1.0E-03						7.5E-17							
231	1737B	FHE-54	Electron beam welding	U-238	1.7E-07	1.0E-03	10.1	0.46	11.5	HEPA	0.01	1.7E-12	1167	E	1.1E-10	671	W	6.0E-08	2
				U-235	2.2E-09	1.0E-03						2.2E-14							
				U-234	1.6E-08	1.0E-03						1.6E-13							
231	1739	FGBE-5	Storage	U-238	1.5E-07	1.0E-06	10.1	0.46	11.5	HEPA	0.01	1.5E-15	1167	E	1.0E-13	671	W	5.4E-11	2
				U-235	2.0E-09	1.0E-06						2.0E-17							
				U-234	1.4E-08	1.0E-06						1.4E-16							
231	1900HB	FGBE-7/8	Storage	U-238	4.9E-06	1.0E-06	2.4	0.20	14.4	None	1	4.9E-12	1167	E	3.3E-10	671	W	2.2E-09	2
				U-235	6.3E-08	1.0E-06						6.3E-14							
				U-234	3.0E-07	1.0E-06						3.0E-13							
231	1944A	Room Air	Mechanical testing	U-238	1.3E-07	1.0E-06	NA	NA	NA	None	1	1.3E-13	1167	E	9.2E-12	671	W	7.6E-11	2
				U-235	1.7E-09	1.0E-06						1.7E-15							
				U-234	1.3E-08	1.0E-06						1.3E-14							
231	1945	FHE-40	Metal characterization	U-238	2.0E-09	1.0E-06	10.7	0.36	3.8	None	1	2.0E-15	1167	E	1.3E-13	671	W	5.4E-13	2
				U-235	2.6E-11	1.0E-06						2.6E-17							
				U-234	1.9E-10	1.0E-06						1.9E-16							
231	1945A	Room Air	Metal characterization	U-238	2.0E-12	1.0E-06	NA	NA	NA	None	1	2.0E-18	1167	E	1.4E-16	671	W	1.2E-15	2
				U-235	2.6E-14	1.0E-06						2.6E-20							
				U-234	1.9E-13	1.0E-06						1.9E-19							
231	1945B	FHE-40	Metal characterization	U-238	1.4E-09	1.0E-03	10.0	0.41	4.6	None	1	1.4E-12	1167	E	8.9E-11	671	W	3.5E-10	2
				U-235	1.7E-11	1.0E-03						1.7E-14							
				U-234	1.3E-10	1.0E-03						1.3E-13							
231	1945C	Room Air	Metal characterization	U-238	2.0E-12	1.0E-06	NA	NA	NA	None	1	2.0E-18	1167	E	1.4E-16	671	W	1.2E-15	2
				U-235	2.6E-14	1.0E-06						2.6E-20							
				U-234	1.9E-13	1.0E-06						1.9E-19							
231	1945D	Room Air	Metal polishing	U-238	2.0E-09	1.0E-06	NA	NA	NA	None	1	2.0E-15	1167	E	1.4E-13	671	W	1.2E-12	2
				U-235	2.6E-11	1.0E-06						2.6E-17							
				U-234	1.9E-10	1.0E-06						1.9E-16							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
231	1945E	Room Air	Wet grinding/polishing	U-238	2.0E-06	1.0E-03	NA	NA	NA	None	1	2.0E-09	1167	E	1.4E-07	671	W	1.2E-06	2
				U-235	2.6E-08	1.0E-03						2.6E-11							
				U-234	1.9E-07	1.0E-03						1.9E-10							
Building 235 is part of the Chemistry and Materials Sciences Directorate. Operations in the facility include examination of material structure, surface, and subsurface; precision cutting, ion implanting, and metallurgical studies.																			
Most of the depleted uranium in this building is used for characterization studies; some is used for ion beam implantation experiments.																			
235	1122	FHE-1A/1B, FHE2A/2B, FGBE-1A/1B	Surface analysis	U-234	1.5E-11	1.0E-06	10.7	2.75	4.0	None	1	1.5E-17	1065	ENE	1.3E-14	556	SW	1.3E-14	2
				U-235	2.1E-12	1.0E-06						2.1E-18							
				U-238	1.6E-10	1.0E-06						1.6E-16							
*Gross alpha and Gross beta emissions are continuously monitored at the stack. Monitoring data, rather than the inventory approach, are used to determine emissions.																			
**Because monitoring takes place after HEPA filtration, an unabated EDE cannot be determined (see discussion on page 38.)																			
235	1130	FHE-1A/1B, FHE2A/2B, FGBE-1A/1B	Preparation of plutonium samples for diamond anvil studies	Gross alpha	*	NA	10.7	2.75	4.0	Double HEPA	0.0001	0.0E+00	**	**	0.0E+00	**	**	**	3
				Gross beta	*	NA						0.0E+00							
235	1131	HDCH-6,7 (FHE-1A/1B, FHE2A/2B, FGBE-1A/1B)	Metallographic sample preparation	U-234	1.1E-08	1.0E-06	10.7	2.75	4.0	HEPA	0.01	1.1E-16	1065	ENE	9.2E-14	556	SW	9.6E-12	2
				U-235	1.5E-09	1.0E-06						1.5E-17							
				U-238	1.2E-07	1.0E-06						1.2E-15							
235	1133	FHE-1A/1B, FHE2A/2B, FGBE-1A/1B	Microstructure examination	U-234	2.8E-09	1.0E-06	10.7	2.75	4.0	None	1	2.8E-15	1065	ENE	2.3E-12	556	SW	2.4E-12	2
				U-235	3.8E-10	1.0E-06						3.8E-16							
				U-238	3.0E-08	1.0E-06						3.0E-14							
235	1235	FHE-1A/1B, FHE2A/2B, FGBE-1A/1B	X-ray diffraction of uranium oxide ceramics	U-234	1.1E-09	1.0E-06	10.7	2.75	14.3	None	1	1.1E-15	1065	ENE	1.5E-13	556	SW	1.6E-13	2
				U-235	4.6E-11	1.0E-06						4.6E-17							
				U-238	9.9E-10	1.0E-06						9.9E-16							
Building 241 is administered by the Chemistry and Material Sciences Directorate for material properties research and testing, and for study of soil bacteria.																			
241	1616	Room Air	Paritcle size analysis of powders	U-238	2.0E-11	1.0E-03	NA	NA	NA	None	1	2.0E-14	1140	E	2.9E-12	697	W	2.2E-11	2
				U-235	9.3E-13	1.0E-03						9.3E-16							
				U-234	2.1E-11	1.0E-03						2.1E-14							
241	1678	FHE-55	Research and development of methods for radionuclide immobilization using uranium oxide	U-238	1.4E-05	1.0E+00	7.9	0.28	15.4	HEPA	0.01	1.4E-07	1140	E	1.8E-05	821	SW	4.4E-03	2
				U-235	6.7E-07	1.0E+00						6.7E-09							
				U-234	1.5E-05	1.0E+00						1.5E-07							
				U-238	9.4E-07	1.0E-03						9.4E-12							
				U-235	4.4E-08	1.0E-03						4.4E-13							
				U-234	1.0E-06	1.0E-03						1.0E-11							
				U-238	1.9E-07	1.0E-06						1.9E-15							
				U-235	8.8E-09	1.0E-06						8.8E-17							
				U-234	2.0E-07	1.0E-06						2.0E-15							
241	1838	FGBE-10	Pressing and sintering of uranium oxide disks	U-238	8.9E-07	1.0E+00	7.6	0.15	12.9	HEPA	0.01	8.9E-09	1140	E	1.2E-06	697	W	5.9E-04	2
				U-235	4.2E-08	1.0E+00						4.2E-10							
				U-234	9.6E-01	1.0E+00						9.6E-03							
				U-238	2.0E-10	1.0E-03						2.0E-15							
				U-235	9.5E-12	1.0E-03						9.5E-17							
				U-234	2.2E-10	1.0E-03						2.2E-15							
				U-238	9.9E-15	1.0E-06						9.9E-23							
				U-235	4.6E-16	1.0E-06						4.6E-24							
				U-234	1.1E-14	1.0E-06						1.1E-22							
241	1838	FHE-7	Weighing and measuring of sintered uranium oxide disks	U-238	4.6E-07	1.0E+00	7.9	0.39	6.6	None	0.01	4.6E-09	1140	E	6.4E-07	697	W	2.5E-04	2
				U-235	2.2E-08	1.0E+00						2.2E-10							
				U-234	5.0E-07	1.0E+00						5.0E-09							
				U-238	9.9E-09	1.0E-03						9.9E-14							
				U-235	4.6E-10	1.0E-03						4.6E-15							
				U-234	1.1E-08	1.0E-03						1.1E-13							
241	1841	FHE-53	Study of bacterial conversion of organic carbon in waste to carbon dioxide	C-14	2.0E-07	1.0E+00	7.9	0.30	11.3	None	1	2.0E-07	1140	E	4.2E-09	697	W	1.3E-08	2
				C-14	4.3E-10	1.0E-03						4.3E-13				754	WNW	1.3E-08	
241	1886	Room Air	Hybridization studies with nucleic acids from soil bacteria	P-32	6.3E-08	1.0E-03	NA	NA	NA	None	1	6.3E-11	1140	E	1.5E-12	754	WNW	1.0E-11	2

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
Building 251, the Heavy Element Facility, is managed by the Safety, Security and Environmental Protection Directorate for the Institutions as a standby, non-operational facility in which transuranic isotopes are stored until they can be disposed.																			
One area of the facility has been "hardened" to resist damage from earthquakes. Room exhausts from this hardened area are double HEPA filtered; glove box exhausts are triple HEPA filtered.																			
Exhausts from the unhardened area, also HEPA filtered, are continuously sampled by simple filter systems.																			
*Stack emissions have been combined as permitted by the EPA/DOE Memorandum of Understanding; measured emissions, rather than the inventory approach, are used to determine annual emissions.																			
**Because monitoring takes place after HEPA filtration, an unabated EDE cannot be determined (see discussion on page 38.)																			
	Unhardened Area*																		
251	1234	CD-01	Out of service	Gross alpha	*	NA	6.8	0.35	5.8	HEPA	0.01	7.0E-09	1185	E	1.4E-06	**	**	**	3
				Gross beta								9.9E-08							
251	1003	FHE-5	General chemistry	Gross alpha	*	NA	4.3	0.26	8.6	HEPA	0.01	0.0E+00	1188	E	0.0E+00	**	**	**	3
	1003	FHE-4		Gross beta			4.3	0.27	4.2			0.0E+00							
	1117	FGBE-21,22					5.5	0.11	7.6										
	1117	FGBE-25,26					8.5	0.10	12.8										
	1117	FGBE-23,24					5.5	0.11	7.6										
	1142	FHE-8					4.3	0.32	4.1										
	1142	FHE-9					4.3	0.26	5.1										
	1142	FHE-10					4.3	0.28	13.7										
	1150	FGBE-33,34					8.0	0.15	12.8										
	1150	FFE-15					4.3	0.31	7.6										
	1165	FGBE-31,32					5.5	0.87	0.1										
	1211	FHE-6					6.4	0.25	8.0										
	1211	FHE-7					6.4	0.25	4.3										
	1212	FGBE-15,16					5.5	0.10	8.0										
	1219	FGBE-27,28					10.5	0.15	3.3										
	1232	FGBE-38,39					7.2	0.15	5.1										
	1234	FFE-9					4.3	0.19	14.7										
	1235	FFE-12					4.3	0.25	7.6										
	1235	FGBE-29,30					5.5	0.13	7.1										
	1301A	FHE-16					6.4	0.31	5.4										
	1363	FGBE-35,36					4.3	0.13	11.2										
	1363	FHE-12					4.3	0.32	9.1										
	1363	FHE-13					6.4	0.28	6.8										
	1364	FFE-23					4.3	0.34	9.1										
	1314, 1354	FGBE-44,45					10.2	0.15	10.2										
	Hot cells	FGBE-40,41					5.5	0.23	5.6										
	Hot cells	FGBE-42,43					5.5	0.36	12.7										
		FFE-13					5.5	0.28	4.1										
	Hardened Area																		
251	Glove Boxes*	FGBE-1000	Previous transuranic research	Gross alpha	*	NA	7.8	0.30	4.8	Triple HEPA	0.000001	0.0E+00	1188	E	0.0E+00	**	**	**	3
		FGBE-2000		Gross beta			7.8	0.30	4.8			0.0E+00							
	Room Exhaust*	FFE-1000		Gross alpha	*	NA	7.8	0.50	11.7	Double HEPA	0.0001	0.0E+00	1188	E	0.0E+00	**	**	**	3
		FFE-2000		Gross beta			7.8	0.50	11.7			0.0E+00							
Building 253 houses the Hazards Control Department, and the facility includes laboratories for the chemical analysis and counting of radioactive samples.																			
253	1708	Room Air	Gross alpha/beta analysis of	Pu-238	2.1E-10	1.0E-06	NA	NA	NA	None	1	2.1E-16	1122	ESE	9.9E-12	736	W	1.4E-10	2
			planchetted, dry samples,	Pu-239	5.1E-09	1.0E-06						5.1E-15							
			air filters and swipes	Pu-240	1.2E-09	1.0E-06						1.2E-15							
				Pu-241	5.2E-08	1.0E-06						5.2E-14							
				Pu-242	7.9E-14	1.0E-06						7.9E-20							
				Am-241	2.5E-10	1.0E-06						2.5E-16							
				U-238	2.8E-08	1.0E-06						2.8E-14							
				U-235	1.3E-09	1.0E-06						1.3E-15							
				U-234	3.0E-08	1.0E-06						3.0E-14							
253	1708A	Room Air	Gross alpha/beta analysis of	Pu-238	2.1E-10	1.0E-06	NA	NA	NA	None	1	2.1E-16	1122	ESE	9.9E-12	736	W	1.4E-10	2
			planchetted, dry samples,	Pu-239	5.1E-09	1.0E-06						5.1E-15							
			air filters and swipes	Pu-240	1.2E-09	1.0E-06						1.2E-15							
				Pu-241	5.2E-08	1.0E-06						5.2E-14							
				Pu-242	7.9E-14	1.0E-06						7.9E-20							
				Am-241	2.5E-10	1.0E-06						2.5E-16							
				U-238	2.8E-08	1.0E-06						2.8E-14							
				U-235	1.3E-09	1.0E-06						1.3E-15							
				U-234	3.0E-08	1.0E-06						3.0E-14							
253	1708B	Room Air	Gross alpha/beta analysis of	Pu-238	2.1E-10	1.0E-06	NA	NA	NA	None	1	2.1E-16	1122	ESE	9.9E-12	736	W	1.4E-10	2
			planchetted, dry samples,	Pu-239	5.1E-09	1.0E-06						5.1E-15							
			air filters and swipes	Pu-240	1.2E-09	1.0E-06						1.2E-15							
				Pu-241	5.2E-08	1.0E-06						5.2E-14							
				Pu-242	7.9E-14	1.0E-06						7.9E-20							
				Am-241	2.5E-10	1.0E-06						2.5E-16							
				U-238	2.8E-08	1.0E-06						2.8E-14							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
253	1708B	(continued)		U-235	1.3E-09	1.0E-06						1.3E-15							
				U-234	3.0E-08	1.0E-06						3.0E-14							
253	1732	FHE-21	Flaming gross alpha/beta planchets	Pu-239	1.3E-13	1.0E+00	6.4	0.30	13.2	None	1	1.3E-13	1122	ESE	2.1E-11	736	W	1.4E-10	2
				Gross alpha	1.2E-13	1.0E+00						1.2E-13				798	WNW	1.4E-10	
				Gross beta	2.3E-13	1.0E+00						2.3E-13							
				H-3	1.1E-12	1.0E+00						1.1E-12							
253	1734	Room Air	Distillation of environmental samples	H-3	6.7E-10	1.0E+00	NA	NA	NA	None	1	6.7E-10	1122	ESE	5.6E-12	736	W	7.8E-11	2
				Gross alpha	5.4E-14	1.0E+00						5.4E-14							
				Gross beta	4.1E-13	1.0E+00						4.1E-13							
253	1734	FGBE-1,2	Sieve soil samples	Gross alpha	2.7E-10	1.0E-06	6.1	0.10	23.6	HEPA	0.01	2.7E-18	1122	ESE	2.5E-16	736	W	2.4E-13	2
				Gross beta	4.6E-10	1.0E-06						4.6E-18							
253	1734	FHE-13	Samples and standards plating	Gross alpha	1.7E-11	1.0E+00	10.4	0.30	12.3	None	1	1.7E-11	1122	ESE	9.2E-11	798	WNW	4.6E-10	2
				Gross beta	2.2E-12	1.0E+00						2.2E-12							
				H-3	1.2E-11	1.0E+00						1.2E-11							
				Sr-90/Y-90	1.7E-12	1.0E+00						1.7E-12							
				Pu-239	7.8E-13	1.0E+00						7.8E-13							
253	1734	FHE-20	Quality control sample aliquoting	Pu-239	2.5E-12	1.0E-03	10.4	0.30	12.3	None	1	2.5E-15	1122	ESE	1.8E-13	798	WNW	9.2E-13	2
				Sr/Y-90	2.2E-12	1.0E-03						2.2E-15							
				H-3	1.1E-10	1.0E-03						1.1E-13							
253	1734	FHE-11	Acid digestion for sample analysis	H-3	6.8E-09	1.0E+00	10.4	0.30	12.3	None	1	6.8E-09	1122	ESE	2.8E-09	798	WNW	1.4E-08	2
				Gross alpha	3.4E-11	1.0E+00						3.4E-11				736	W	1.4E-08	
				Gross beta	2.2E-10	1.0E+00						2.2E-10							
				Sr/Y-90	2.8E-12	1.0E+00						2.8E-12							
				Pu-239	3.1E-12	1.0E+00						3.1E-12							
253	1910	FHE-22	Preparations of calibration standards	H-3	3.0E-11	1.0E-03	7.0	0.20	5.2	None	1	3.0E-14	1122	ESE	1.8E-15	736	W	2.1E-14	2
				C-14	1.5E-11	1.0E-03						1.5E-14							
				P-32	1.5E-10	1.0E-03						1.5E-13							
Building 254 is run by Hazards Control for the purpose of conducting bioassays and providing analytical services.																			
254	108	FHE-1000	Analysis of urine for radionuclides	Am-243	1.3E-17	1.0E-03	8.2	1.07	5.3	None	1	1.3E-20	1038	ESE	3.7E-17	1070	NNE	1.4E-16	2
				Pu-242	1.6E-16	1.0E-03						1.6E-19				1055	SW	1.4E-16	
				Pu-239	2.6E-17	1.0E-03						2.6E-20				849	WNW	1.4E-16	
				H-3	1.4E-14	1.0E-03						1.4E-17							
				Sr-90	3.1E-14	1.0E-03						3.1E-17							
				Y-90	3.1E-14	1.0E-03						3.1E-17							
254	109	FHE-1000	Analysis of urine for radionuclides	Am-243	1.3E-17	1.0E-03	8.2	1.07	5.3	None	1	1.3E-20	1038	ESE	1.5E-18	1070	NNE	5.9E-18	2
254	110	FHE-1000	Analysis of urine for radionuclides	Am-241	8.2E-19	1.0E-03	8.2	1.07	5.3	None	1	8.2E-22	1038	ESE	1.3E-11	1070	NNE	5.0E-11	2
				Am-243	2.3E-17	1.0E-03						2.3E-20							
				Cm-244	8.7E-18	1.0E-03						8.7E-21							
				Np-237	1.1E-15	1.0E-03						1.1E-18							
				Th-230	8.9E-17	1.0E-03						8.9E-20							
				Cf-252	8.0E-17	1.0E-03						8.0E-20							
				U-233	2.7E-19	1.0E-03						2.7E-22							
				U-234	2.6E-18	1.0E-03						2.6E-21							
				U-235	2.7E-19	1.0E-03						2.7E-22							
				U-236	8.3E-17	1.0E-03						8.3E-20							
				U-238	6.3E-21	1.0E-03						6.3E-24							
				Mixed gamma	4.5E-12	1.0E-03						4.5E-15							
				Cf-249	6.7E-13	1.0E-03						6.7E-16							
				U-232	6.4E-13	1.0E-03						6.4E-16							
				Po-209	7.1E-14	1.0E-03						7.1E-17							
				Pu-242	1.4E-13	1.0E-03						1.4E-16							
				Pu-239	2.2E-14	1.0E-03						2.2E-17							
				P-32	7.0E-12	1.0E-03						7.0E-15							
				S-35	3.2E-12	1.0E-03						3.2E-15							
				C-14	5.6E-12	1.0E-03						5.6E-15							
				P-33	1.1E-12	1.0E-03						1.1E-15							
				I-125	9.0E-13	1.0E-03						9.0E-16							
				Sr-90	5.0E-14	1.0E-03						5.0E-17							
				Y-90	5.0E-14	1.0E-03						5.0E-17							
				Np-237	1.1E-10	1.0E-03						1.1E-13							
				Np-239	6.2E-10	1.0E-03						6.2E-13							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
254	110	(continued)		Cm-242	9.1E-13	1.0E-03						9.1E-16							
				Th-230	9.4E-12	1.0E-03						9.4E-15							
				Cf-252	8.4E-12	1.0E-03						8.4E-15							
				U-233	2.2E-16	1.0E-03						2.2E-19							
				U-234	8.2E-15	1.0E-03						8.2E-18							
				U-235	2.3E-16	1.0E-03						2.3E-19							
				U-236	5.8E-14	1.0E-03						5.8E-17							
				U-238	2.0E-15	1.0E-03						2.0E-18							
254	113	FHE-1000	Analysis of urine for radionuclides	Pu-242	1.6E-16	1.0E-03	8.2	1.07	5.3	None	1	1.6E-19	1038	ESE	3.8E-17	1070	NNE	1.4E-16	2
				Pu-239	2.6E-17	1.0E-03						2.6E-20				1055	SW	1.4E-16	
				H-3	1.4E-14	1.0E-03						1.4E-17				817	W	1.4E-16	
				C-14	1.4E-14	1.0E-03						1.4E-17				849	WNW	1.4E-16	
				Sr-90	3.1E-14	1.0E-03						3.1E-17							
				Y-90	3.1E-14	1.0E-03						3.1E-17							
				Am-243	1.3E-17	1.0E-03						1.3E-20							
Building 255 is operated by Hazards Control and houses a radiation calibration and standards laboratory. Many operations involve the use of sealed sources.																			
255	165	FHE-4	Analysis of urine for radionuclides	I-125	2.3E-09	1.0E-03	6.9	0.30	5.1	None	1	2.3E-12	1056	E	6.1E-12	790	W	1.8E-11	2
				I-131	7.2E-09	1.0E-03						7.2E-12							
				Th-230	5.7E-14	1.0E-03						5.7E-17							
				Th-232	1.0E-16	1.0E-03						1.0E-19							
				U-233	1.0E-11	1.0E-03						1.0E-14							
				U-238	1.3E-15	1.0E-03						1.3E-18							
				Np-237	5.7E-14	1.0E-03						5.7E-17							
				Cm-244	3.8E-14	1.0E-03						3.8E-17							
				Am-241	3.8E-15	1.0E-03						3.8E-18							
				Am-243	1.9E-14	1.0E-03						1.9E-17							
				Pu-239	1.9E-14	1.0E-03						1.9E-17							
				Pu-242	1.9E-15	1.0E-03						1.9E-18							
255	180	FHE-2	Tritium gas monitor calibrations	H-3	2.5E-02	1.0E+00	8.1	0.31	5.2	None	1	2.5E-02	1056	E	9.9E-06	790	W	3.9E-05	2
Building 281 is part of the Energy and Environment Directorate. Tracer work, dissolution studies and flow studies are conducted in this building.																			
281	1174	FHE-13	Tracer work	Ni-63	1.0E-05	1.0E-03	6.7	0.30	6.1	None	1	1.0E-08	1332	ESE	2.4E-11	579	NNE	3.1E-10	2
281	1305	Room air	Dissolution studies	U-238	4.3E-09	1.0E-03	NA	NA	NA	None	1	4.3E-12	1332	ESE	1.0E-10	753	WNW	1.8E-09	2
281	1307	FHE-6	Tracer work	Np-237	2.5E-12	1.0E-03	6.4	0.61	2.7	None	1	2.5E-15	1332	ESE	4.0E-08	753	WNW	5.6E-07	2
				U-238	4.10E-14	1.0E-03						4.1E-17							
				U-235	5.28E-16	1.0E-03						5.3E-19							
				U-234	3.83E-15	1.0E-03						3.8E-18							
				Pu-239	3.3E-07	1.0E-03						3.3E-10							
				Pu-242	2.1E-11	1.0E-03						2.1E-14							
				U-233	2.3E-08	1.0E-03						2.3E-11							
				Pu-244	1.6E-09	1.0E-03						1.6E-12							
				Ni-63	2.0E-04	1.0E-03						2.0E-07							
				Ni-59	7.0E-08	1.0E-03						7.0E-11							
				Tc-99	1.0E-07	1.0E-03						1.0E-10							
				Sr-90	1.0E-05	1.0E-03						1.0E-08							
				Ca-41	1.0E-04	1.0E-03						1.0E-07							
				Be-10	1.0E-05	1.0E-03						1.0E-08							
				Pu-239/U-233	1.0E-07	1.0E-03						1.0E-10							
281	1311	FHE-12	Solution preparation	C-14	1.9E-04	1.0E-03	6.1	0.41	4.0	None	1	1.9E-07	1332	ESE	4.0E-09	753	WNW	5.5E-08	2
				Cl-36	1.0E-05	1.0E-03						1.0E-08							
				H-3	2.5E-05	1.0E-03						2.5E-08							
281	1323	FHE-1	Radioactivity migration studies	Na-22	8.0E-08	1.0E-03	6.7	0.30	6.1	None	1	8.0E-11	1332	ESE	6.2E-09	579	NNE	8.3E-08	2
				U-238	1.2E-07	1.0E-03						1.2E-10							
				U-235	5.5E-09	1.0E-03						5.5E-12							
				U-234	1.3E-07	1.0E-03						1.3E-10							
Building 282 is administered by the Physics and Space Directorate. Residual contamination exists in the facility from past operations.																			
282	1000	Room Air	Contamination	H-3	4.0E-06	1.0E-03	NA	NA	NA	None	1	4.0E-09	1332	ESE	6.2E-13	753	WNW	1.1E-11	2

Attachment 1 - 2001 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
Building 292 is administered by the Environmental Programs Directorate. Residual contamination exists throughout the facility from the past operation of a rotating target neutron source.																			
292	1200,1202	Room Air	Contamination	H-3	1.8E+00	1.0E-03	NA	NA	NA	None	1	1.8E-03	1380	ESE	3.9E-06	655	W	9.2E-05	2
	1204	Room Air	Contamination	H-3	2.3E+01	1.0E-03	NA	NA	NA	None	1	2.3E-02							
	1402, 1402A	Room Air	Contamination	H-3	1.8E+00	1.0E-03	NA	NA	NA	None	1	1.8E-03							
	1404, 1406																		
	1407																		
Building 298 is part of the Laser Fusion Program. Small amounts of tritium are used in this facility in conjunction with fusion target research and development.																			
298	160	Room Air	D-T layering experiment	H-3	4.0E-03	1.0E+00	NA	NA	NA	None	1	4.0E-03	1398	SE	5.7E-07	264	NNE	3.0E-05	2
298	189	FHE-14	Laser fusion target coating	U-238	1.3E-04	1.0E-03	6.4	0.63	15.1	HEPA	0.01	1.3E-09	1398	SE	1.9E-08	344	NE	6.3E-05	2
298	Various	Room Air	Laser fusion target research and development	H-3	1.0E-03	1.0E+00	NA	NA	NA	None	1	1.0E-03	1398	SE	1.4E-07	264	NNE	7.6E-06	2
Buildings 321, 321A, 321B, and 321C are the Material Fabrication Shops and are part of the Mechanical Engineering Department. Operations in this complex include milling, shaping and machining of depleted uranium. Uranium pieces may be worked on in a single location, or may be moved from machine to machine. In addition, depleted uranium parts occasionally undergo heat treatment. The amount of depleted uranium that is handled depends on programmatic demands and varies from month to month. NOTE: Machining only occurs in 321C. **Stack emissions have been combined as permitted by the EPA/DOE Memorandum of Understanding.																			
321A	1001A	FHE-24	Machining and manufacturing	U-234	7.5E-04	1.0E-06	3.7	0.46	2.9	HEPA	0.01	7.5E-12	1032	ENE	1.10E-08	326	SW	8.3E-06	2
				U-235	1.0E-04	1.0E-06						1.0E-12							
				U-238	8.1E-03	1.0E-06						8.1E-11							
321C	234B	FHE-13	Lapping of DU metal	U-238	1.6E-04	1.0E-06	10.7	0.49	2.5	None	1	1.6E-10	1032	ENE	1.80E-08	326	SW	4.2E-08	2
				U-235	2.0E-06	1.0E-06						2.0E-12							
				U-234	9.4E-06	1.0E-06						9.4E-12							
321C	Various**	FHE-9	Machining and manufacturing	U-234	3.2E+00	1.0E-06	8.5	0.31	16.1	HEPA	0.01	3.2E-08	1032	ENE	3.4E-08	252	SW	6.2E-06	2
		FHE-11		U-235	4.0E-02	1.0E-06	12.5	0.60	6.0	HEPA	0.01	4.0E-10							
		FHE-15		U-238	3.0E-01	1.0E-06	11.2	0.23	13.4	HEPA	0.01	3.0E-09							
		FEV-1000					11.3	0.83	6.5	HEPA	0.01								
Building 322 is operated by the Mechanical Engineering Department.																			
322	109	FHE-1	Cleaning and plating of depleted uranium	U-234	3.1E-07	1.0E-06	7.9	0.35	1.0	None	1	3.1E-13	930	ENE	5.0E-10	416	SW	1.8E-09	2
				U-235	4.3E-08	1.0E-06						4.3E-14							
				U-238	3.3E-06	1.0E-06						3.3E-12							
Building 327 is operated by the Mechanical Engineering Department.																			
327	1275	Room Air	Non-destructive ultrasonic material evaluation	U-234	1.3E-05	1.0E-06	NA	NA	NA	None	1	1.3E-11	1018	ENE	1.9E-08	425	SW	1.2E-07	2
				U-235	1.9E-06	1.0E-06						1.9E-12							
				U-238	1.4E-04	1.0E-06						1.4E-10							
Building 331 is operated by the Defense and Nuclear Technologies Directorate. The building houses the tritium research facility and associated laboratories. *Tritium HT and HTO emissions from the two 30-m stacks are continuously monitored in compliance with NESHAPs regulations. Monitoring data, rather than the inventory approach, are used to determine emissions. **Stack emissions have been combined as permitted by the EPA/DOE Memorandum of Understanding. ***Calculated dose of 4.3E-03 mrem includes modeling the HT emissions as HTO, as directed by U.S. EPA, Region IX. The dose from HT and HTO emissions calculated appropriately using the NEWTRIT model is 3.1e-03. See discussion on page 30.																			
331	All**	Stack 1	Tritium research and development	H-3	*	1.0E+00	30.0	1.22	7.6	None	1	2.7E+00	957	ENE	4.3E-03	957	ENE	4.3E-03	3
		Stack 2	Decontamination of parts	H-3	*	1.0E+00	30.0	1.22	10.5	None	1	1.7E+01		3.1E-03 ***				3.1E-03 ***	
Building 332 is operated by the Defense Sciences Program for plutonium research. Exhausts from glove box operations and the workplace are triply filtered by high efficiency particulate air (HEPA) filters. Exhausts are monitored with both continuous filter sampling (PAMs) and plutonium-specific, continuous real-time monitors (CAMs). *Because building plutonium inventory and the plutonium associated with specific tasks is classified, the standard NESHAPs approach, based on inventory, cannot be utilized without classifying this report. The air monitoring data for all emission points show no detectable released plutonium activity, i.e. at or below the limit of sensitivity of the analytical analysis. **Because monitoring takes place after HEPA filtration, an unabated EDE cannot be determined (see discussion on page 38.)																			
332	Increment 1 Rooms	FHE-1000/2000	Plutonium research	Transuranics	*	NA	8.8	0.8x1.1	17.3	Double HEPA	0.000001	0.0E+00	912	ENE	0.0E+00	**	**	**	3
332	Increment 1 Glove boxes	FGBE-1000/2000	Plutonium research	Transuranics	*	NA	11	0.3	6.9	Triple HEPA	0.000001	0.0E+00	912	ENE	0.0E+00	**	**	**	3
332	Downdraft	FHE-4/5	Plutonium research	Transuranics	*	NA	11	0.2	14.2	Double HEPA	0.0001	0.0E+00	912	ENE	0.0E+00	**	**	**	3
332	Loft	FE-4	Plutonium research	Transuranics	*	NA	11	0.6x0.9	4.6	HEPA	0.01	0.0E+00	912	ENE	0.0E+00	**	**	**	3
		FE-5	Plutonium research	Transuranics	*	NA	11	0.6x0.9	4.6	HEPA	0.01	0.0E+00	912	ENE	0.0E+00	**	**	**	3
332	Increment 1 Glove boxes	FGBE-3000/4000	Plutonium research	Transuranics	*	NA	11	0.3	2	Triple HEPA	0.000001	0.0E+00	912	ENE	0.0E+00	**	**	**	3

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
332	Increment 3	FFE-1000/2000	Plutonium research	Transuranics	*	NA	10.1	0.9	12.2	Room—Double HEPA	0.000001	0.0E+00	912	ENE	0.0E+00	**	**	**	3
	Room and	FGBE-7000/8000								Glove Box—Triple HEPA									
	Glove boxes																		
Building 341 is a Lasers Directorate facility.																			
341	1107	Room Air	Blower decontamination	U-238	9.6E-10	1.00E-03	NA	NA	NA	None	1	9.6E-13	872	E	1.1E-10	770	SW	2.90E-10	2
				U-235	1.2E-11	1.00E-03						1.2E-14				591	SSW	2.90E-10	
				U-234	8.9E-11	1.00E-03						8.9E-14							
The research complex for the Biology and Biotechnology Research Directorate includes Buildings 361, 362, 363, 364, 365, 366 and 377. Building 365 contains																			
small amounts of tritium, carbon-14 and sulfur-35 used in animal research, and incorporated in animal carcasses stored frozen pending disposal. The building air is filtered through																			
at least two HEPA filters and one charcoal filter before being exhausted. Most of the organs that contained radionuclides have been removed from the animals for examination.																			
The radionuclide sources in Building 361 include tritium, carbon-14, phosphorous-32, phosphorous-33, and sulfur-35, mostly incorporated as constituent atoms (tracers) in organic compounds.																			
361	1020	Room Air	DNA hybridization	P-32	1.3E-03	1.0E-03	NA	NA	NA	None	1	1.3E-06	918	ESE	2.1E-08	976	W	1.1E-07	2
361	1238	Room Air	P-32 Labeling	P-32	8.0E-05	1.0E-03	NA	NA	NA	None	1	8.0E-08	918	ESE	1.3E-09	976	W	7.0E-09	2
361	1445	Room Air	Radiolabeling of DNA substrates	P-32	2.2E-04	1.0E-03	NA	NA	NA	None	1	2.2E-07	918	ESE	6.2E-09	976	W	3.4E-08	2
				S-35	4.1E-04	1.0E-03						4.1E-07							
361	1446	FHE-15	Radiolabeling of DNA substrates	P-32	5.5E-04	1.0E-03	6.2	0.42	1.7	None	1	5.5E-07	918	ESE	8.7E-09	976	W	4.7E-08	2
361	1542	FHE-12	Hybridization and enzyme assay	P-32	2.0E-07	1.0E-03	7.0	0.41	4.4	None	1	2.0E-10	918	ESE	2.9E-12	976	W	1.5E-11	2
361	1546	FHE-10	DNA protein interaction studies	P-32	3.2E-04	1.0E-03	1.7	0.41	0.5	None	1	3.2E-07	918	ESE	4.9E-09	976	W	2.5E-08	2
361	1664	Room Air	DNA hybridization	P-32	6.4E-04	1.0E-03	NA	NA	NA	None	1	6.4E-07	918	ESE	1.0E-08	976	W	5.6E-08	2
361	1742	FHE-8	DNA hybridization	P-32	2.2E-04	1.0E-03	7.0	0.41	4.4	None	1	2.2E-07	918	ESE	3.3E-09	976	W	1.7E-08	2
361	1846	Room Air	Human genome research	P-32	2.6E-04	1.0E-03	NA	NA	NA	None	1	2.6E-07	918	ESE	4.2E-09	976	W	2.3E-08	2
Building 362																			
362	105	FHE-1000	Compound purification by HPLC	H-3	1.0E-04	1.0E-03	6.8	0.65	2.7	None	1	1.0E-07	992	ESE	1.4E-09	893	W	9.4E-09	2
				C-14	1.0E-04	1.0E-03						1.0E-07							
362	106	FHE-1000	Characterization of	C-14	1.0E-08	1.0E-03	6.8	0.65	2.7	None	1	1.0E-11	992	ESE	6.7E-09	893	W	4.6E-08	2
			metabolic pathways	H-3	5.0E-04	1.0E-03						5.0E-07							
Building 363																			
363	1009	FHE-2000	Human urine sample project	H-3	1.0E-09	1.0E-03	1.7	0.41	0.4	HEPA	0.01	1.0E-14	1000	ESE	1.5E-16	888	W	1.2E-13	2
				C-14	1.0E-09	1.0E-03						1.0E-14							
363	1010	Room Air	HPLC analysis	H-3	1.0E-09	1.0E-03	NA	NA	NA	None	1	1.0E-12	1000	ESE	1.6E-14	888	W	1.3E-13	2
				C-14	1.0E-09	1.0E-03						1.0E-12							
Building 364																			
364	1509	FHE-02P	AMS sample preparation	H-3	5.5E-14	1.0E+00	5.5	0.52	2.9	None	1	5.5E-14	987	ESE	8.6E-09	912	W	6.8E-08	2
				C-14	5.5E-07	1.0E+00						5.5E-07							
364	1509A	Room Air	AMS sample preparation	H-3	5.5E-14	1.0E+00	NA	NA	NA	None	1	5.5E-14	987	ESE	7.9E-09	912	W	5.6E-08	2
				C-14	5.5E-07	1.0E+00						5.5E-07							
364	1519	Room Air	DNA and protein extraction	C-14	5.0E-06	1.0E-03	NA	NA	NA	None	1	5.0E-09	987	ESE	8.0E-11	912	W	6.3E-10	2
				H-3	5.0E-06	1.0E-03						5.0E-09							
Building 365																			
365	104	FHE-1000	Equipment decontamination	C-14	1.0E-09	1.0E-03	6.1	0.58	7.2	HEPA	0.01	1.0E-14	991	ESE	1.2E-16	902	W	6.1E-14	2
				H-3	1.0E-09	1.0E-03						1.0E-14							
365	109	FHE-5	Animal housing	C-14	1.3E-05	1.0E-03	1.7	0.41	0.6	Double HEPA	0.0001	1.3E-12	991	ESE	2.0E-14	902	W	1.6E-09	2
				H-3	5.0E-08	1.0E-03						5.0E-15							
Building 366																			
366	111	Room Air	Labeling	P-32	2.0E-03	1.0E-03	NA	NA	NA	None	1	2.0E-06	925	ESE	3.2E-08	998	W	1.7E-07	2
Building 378 is part of the Energy and Environment Directorate. Small quantities of radioactive tracers are handled in this building.																			
378	105	FHE-1,11	Tracer work	Am-243	9.2E-12	1.0E-03	8.5	0.30	5.8	None	1	9.2E-15	875	ESE	4.2E-12	1041	W	1.9E-11	2
				Pu-239	1.5E-14	1.0E-03						1.5E-17							
				Pu-242	1.5E-12	1.0E-03						1.5E-15							
				U-233	4.6E-11	1.0E-03						4.6E-14							

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
378	120	FHE-1,2,3,4,5,8,9,10	Tracer work	Am-241	1.2E-08	1.0E-03	8.5	0.30	5.9	None	1	1.2E-11	875	ESE	2.6E-09	1041	W	1.2E-08	2
				Am-243	7.7E-11	1.0E-03						7.7E-14							
				Cd-109	7.7E-09	1.0E-03						7.7E-12							
				Co-57	3.1E-10	1.0E-03						3.1E-13							
				Co-60	1.2E-08	1.0E-03						1.2E-11							
				Cs-134	1.5E-07	1.0E-03						1.5E-10							
				Cs-137	1.5E-08	1.0E-03						1.5E-11							
				Np-237	3.1E-13	1.0E-03						3.1E-16							
				Pu-239	1.5E-11	1.0E-03						1.5E-14							
				Pu-240	1.2E-11	1.0E-03						1.2E-14							
				Pu-242	1.5E-12	1.0E-03						1.5E-15							
				Pu-244	7.7E-11	1.0E-03						7.7E-14							
				Sr-85	1.4E-08	1.0E-03						1.4E-11							
				U-238	1.5E-13	1.0E-03						1.5E-16							
				U-235	6.8E-15	1.0E-03						6.8E-18							
				U-234	1.6E-13	1.0E-03						1.6E-16							
				U-238	2.8E-13	1.0E-03						2.8E-16							
				U-235	3.6E-15	1.0E-03						3.6E-18							
				U-234	2.6E-14	1.0E-03						2.6E-17							
Building 491 was part of the Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program, operated by The United States Enrichment Corporation (USEC). In June 1999, USEC suspended further development of the U-AVLIS technology.																			
Stack sampling is continuous. The facility operates with two in-series high efficiency particulate (HEPA) filter banks to control emissions.																			
*Air emissions are continuously sampled at the post-HEPA-filter atmospheric discharge points, although emissions are low enough that stack monitoring is not required per the NESHAPs 40 CFR 61 regulations.																			
**Because monitoring takes place after HEPA filtration, an unabated EDE cannot be determined (see discussion on page 38.)																			
491	All	FFE-1	Out of service	Gross alpha	*	NA	9.1	0.9	12.1	Double HEPA	0.0001	0.0E+00	1000	SSE	0.0E+00	**	**	**	3
				Gross beta	*							0.0E+00							
Building 513 is operated by the Hazardous Waste Management Division. The Stabilization Unit is a mechanized mixing device used to make homogeneous mixtures of waste. Solidification agents are added during mixing to transfer sludges to solids.																			
The Microfiltration Unit filters out waste radioactive particles. In the Laboratory, small quantities of waste materials are sampled, treated, and stored. No releases are assumed to occur from waste storage because the wastes are fully contained.																			
513	Stabilization	Room Air	Treatment of hazardous, mixed or radioactive waste	H-3	4.6E-03	1.0E-03	NA	NA	NA	None	1	4.6E-06	588	NE	1.1E-06	217	SW	2.3E-06	1
				Pu-239	1.5E-07	1.0E-03						1.5E-10							
				Th-232	1.2E-07	1.0E-03						1.2E-10							
				U-234	1.2E-07	1.0E-03						1.2E-10							
				U-235	1.6E-08	1.0E-03						1.6E-11							
				U-238	1.3E-06	1.0E-03						1.3E-09							
513	1000A	FHE-4	Process optimization and treatibility studies	I-125	7.8E-07	1.0E-03	10.5	0.30	5.5	HEPA	0.01	7.8E-12	588	NE	8.7E-09	128	SW	1.3E-08	2
				I-131	2.8E-08	1.0E-03						2.8E-13							
				Cs-137	2.5E-07	1.0E-03						2.5E-12							
				C-14	2.6E-04	1.0E-03						2.6E-09							
				Cs-134	3.1E-08	1.0E-03						3.1E-13							
				Ba-133	2.0E-09	1.0E-03						2.0E-14							
				P-32	3.3E-06	1.0E-03						3.3E-11							
				Pu-238	1.8E-09	1.0E-03						1.8E-14							
				Pu-239	1.4E-07	1.0E-03						1.4E-12							
				Pu-240	2.1E-08	1.0E-03						2.1E-13							
				Am-241	4.2E-08	1.0E-03						4.2E-13							
				Pu-241	1.3E-06	1.0E-03						1.3E-11							
				Th-232	4.6E-09	1.0E-03						4.6E-14							
				Pu-242	7.1E-07	1.0E-03						7.1E-12							
514	108	Room Air	Vacuum filtration of treated waste water	Am-241	3.2E-06	1.00E-03	NA	NA	NA	None	1	3.2E-09	528	NE	2.7E-05	217	SW	5.5E-05	1
				Am-243	2.4E-07	1.00E-03						2.4E-10							
				Ba-133	2.9E-07	1.00E-03						2.9E-10							
				Bi-207	1.4E-08	1.00E-03						1.4E-11							
				Bi-210	1.6E-08	1.00E-03						1.6E-11							
				C-14	1.6E-05	1.00E-03						1.6E-08							
				Cd-109	4.8E-11	1.00E-03						4.8E-14							
				Ce-139	1.6E-14	1.00E-03						1.6E-17							
				Ce-144	1.6E-06	1.00E-03						1.6E-09							
				Cf-249	1.6E-08	1.00E-03						1.6E-11							
				Cm-244	1.9E-07	1.00E-03						1.9E-10							
				Co-56	3.2E-09	1.00E-03						3.2E-12							
				Co-57	8.6E-08	1.00E-03						8.6E-11							
				Co-60	5.0E-08	1.00E-03						5.0E-11							
				Cs-134	1.9E-07	1.00E-03						1.9E-10							
				Cs-137	8.0E-06	1.00E-03						8.0E-09							
				Eu-152	7.8E-07	1.00E-03						7.8E-10							
				Eu-154	7.7E-07	1.00E-03						7.7E-10							
				Eu-155	5.9E-08	1.00E-03						5.9E-11							
				Gd-148	1.9E-07	1.00E-03						1.9E-10							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
514	108	(continued)		H-3	4.5E-05	1.00E-03						4.5E-08							
				K-40	6.4E-07	1.00E-03						6.4E-10							
				Mn-54	3.7E-08	1.00E-03						3.7E-11							
				Na-22	4.5E-09	1.00E-03						4.5E-12							
				Nb-95	2.2E-09	1.00E-03						2.2E-12							
				Ni-63	1.6E-09	1.00E-03						1.6E-12							
				Np-237	1.9E-07	1.00E-03						1.9E-10							
				Np-239	3.8E-09	1.00E-03						3.8E-12							
				P-32	9.6E-07	1.00E-03						9.6E-10							
				Pb-210	2.1E-07	1.00E-03						2.1E-10							
				Po-209	1.6E-08	1.00E-03						1.6E-11							
				Po-210	1.6E-08	1.00E-03						1.6E-11							
				Pu-238	2.1E-07	1.00E-03						2.1E-10							
				Pu-239	4.8E-06	1.00E-03						4.8E-09							
				Pu-241	5.8E-07	1.00E-03						5.8E-10							
				Pu-242	5.6E-07	1.00E-03						5.6E-10							
				Pu-244	1.6E-10	1.00E-03						1.6E-13							
				Ra-226	1.6E-08	1.00E-03						1.6E-11							
				Sb-125	5.9E-08	1.00E-03						5.9E-11							
				Sr-90	1.6E-05	1.00E-03						1.6E-08							
				Tc-99	1.9E-07	1.00E-03						1.9E-10							
				Th-228	2.4E-09	1.00E-03						2.4E-12							
				Th-229	1.9E-07	1.00E-03						1.9E-10							
				Th-230	1.9E-07	1.00E-03						1.9E-10							
				Th-232	1.9E-07	1.00E-03						1.9E-10							
				U-232	1.9E-07	1.00E-03						1.9E-10							
				U-233	4.2E-07	1.00E-03						4.2E-10							
				U-234	3.1E-06	1.00E-03						3.1E-09							
				U-235	2.0E-07	1.00E-03						2.0E-10							
				U-238	1.1E-05	1.00E-03						1.1E-08							
				Y-88	9.3E-09	1.00E-03						9.3E-12							
514	Evaporator	Room Air	Waste consolidation	Am-241	1.0E-04	1.0E-03	NA	NA	NA	None	1	1.0E-07	528	NE	5.8E-04	217	SW	1.2E-03	1
				Am-243	3.0E-06	1.0E-03						3.0E-09							
				Ba-133	3.6E-06	1.0E-03						3.6E-09							
				Bi-207	1.7E-07	1.0E-03						1.7E-10							
				Bi-210	2.0E-07	1.0E-03						2.0E-10							
				C-14	2.0E-04	1.0E-03						2.0E-07							
				Cd-109	6.0E-10	1.0E-03						6.0E-13							
				Ce-139	2.0E-13	1.0E-03						2.0E-16							
				Ce-144	2.0E-05	1.0E-03						2.0E-08							
				Cf-249	2.0E-07	1.0E-03						2.0E-10							
				Cm-244	2.4E-06	1.0E-03						2.4E-09							
				Co-56	4.0E-08	1.0E-03						4.0E-11							
				Co-57	1.1E-06	1.0E-03						1.1E-09							
				Co-60	6.4E-07	1.0E-03						6.4E-10							
				Cs-134	2.4E-06	1.0E-03						2.4E-09							
				Cs-137	1.0E-04	1.0E-03						1.0E-07							
				Eu-152	9.7E-06	1.0E-03						9.7E-09							
				Eu-154	9.7E-06	1.0E-03						9.7E-09							
				Eu-155	7.4E-07	1.0E-03						7.4E-10							
				Gd-148	2.4E-06	1.0E-03						2.4E-09							
				H-3	1.2E-02	1.0E-03						1.2E-05							
				K-40	8.0E-06	1.0E-03						8.0E-09							
				Mn-54	4.7E-07	1.0E-03						4.7E-10							
				Na-22	5.7E-08	1.0E-03						5.7E-11							
				Nb-95	2.7E-08	1.0E-03						2.7E-11							
				Ni-63	2.0E-08	1.0E-03						2.0E-11							
				Np-237	2.4E-06	1.0E-03						2.4E-09							
				Np-239	4.8E-08	1.0E-03						4.8E-11							
				P-32	6.4E-04	1.0E-03						6.4E-07							
				Pb-210	2.6E-06	1.0E-03						2.6E-09							
				Po-209	2.0E-07	1.0E-03						2.0E-10							
				Po-210	2.0E-07	1.0E-03						2.0E-10							
				Pu-238	2.8E-06	1.0E-03						2.8E-09							
				Pu-239	6.0E-05	1.0E-03						6.0E-08							
				Pu-240	1.1E-06	1.0E-03						1.1E-09							
				Pu-241	1.8E-05	1.0E-03						1.8E-08							
				Pu-242	7.0E-06	1.0E-03						7.0E-09							
				Pu-244	2.0E-09	1.0E-03						2.0E-12							
				Ra-226	2.0E-07	1.0E-03						2.0E-10							
				Sb-125	7.4E-07	1.0E-03						7.4E-10							
				Sr-90	2.0E-04	1.0E-03						2.0E-07							
				Tc-99	2.4E-06	1.0E-03						2.4E-09							

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
514	Evaporator	(continued)		Th-228	3.0E-08	1.0E-03						3.0E-11							
				Th-229	2.4E-06	1.0E-03						2.4E-09							
				Th-230	2.4E-06	1.0E-03						2.4E-09							
				Th-232	7.5E-06	1.0E-03						7.5E-09							
				U-232	2.4E-06	1.0E-03						2.4E-09							
				U-233	5.2E-06	1.0E-03						5.2E-09							
				U-234	1.3E-04	1.0E-03						1.3E-07							
				U-235	6.5E-06	1.0E-03						6.5E-09							
				U-238	2.3E-04	1.0E-03						2.3E-07							
				Y-88	1.2E-07	1.0E-03						1.2E-10							
Building 612 is operated by the Hazardous Waste Management Division. It is a facility in which waste is repackaged for shipment off site.																			
612	100	Room Air	Waste sampling	Am-241	6.3E-08	1.0E-06	NA	NA	NA	None	1	6.3E-14	444	NNE	1.1E-06	276	SW	2.3E-06	2
				Am-243	5.3E-13	1.0E-06						5.3E-19							
				Au-195	3.1E-12	1.0E-06						3.1E-18							
				Ba-133	1.3E-10	1.0E-06						1.3E-16							
				Ba-140	4.2E-09	1.0E-06						4.2E-15							
				Be-7	1.8E-09	1.0E-06						1.8E-15							
				C-14	1.0E-04	1.0E-06						1.0E-10							
				Cd-109	2.5E-12	1.0E-06						2.5E-18							
				Ce-141	1.6E-08	1.0E-06						1.6E-14							
				Ce-144	1.4E-08	1.0E-06						1.4E-14							
				Cf-250	9.1E-13	1.0E-06						9.1E-19							
				Cl-36	2.1E-11	1.0E-06						2.1E-17							
				Co-60	2.1E-08	1.0E-06						2.1E-14							
				Cr-51	9.1E-10	1.0E-06						9.1E-16							
				Cs-134	2.0E-09	1.0E-06						2.0E-15							
				Cs-137	4.5E-08	1.0E-06						4.5E-14							
				Eu-152	9.1E-10	1.0E-06						9.1E-16							
				Eu-154	9.1E-10	1.0E-06						9.1E-16							
				Eu-155	9.2E-10	1.0E-06						9.2E-16							
				Fe-55	5.5E-09	1.0E-06						5.5E-15							
				H-3	2.3E-03	1.0E-06						2.3E-09							
				I-125	5.2E-08	1.0E-06						5.2E-14							
				I-131	1.8E-09	1.0E-06						1.8E-15							
				K-40	7.7E-10	1.0E-06						7.7E-16							
				Mn-54	1.2E-10	1.0E-06						1.2E-16							
				Mo-99	8.9E-10	1.0E-06						8.9E-16							
				Nb-94	9.1E-10	1.0E-06						9.1E-16							
				Nb-95	1.4E-08	1.0E-06						1.4E-14							
				Nd-147	9.1E-10	1.0E-06						9.1E-16							
				Np-237	4.0E-15	1.0E-06						4.0E-21							
				Np-239	7.3E-10	1.0E-06						7.3E-16							
				P-32	1.7E-05	1.0E-06						1.7E-11							
				Pm-147	8.2E-11	1.0E-06						8.2E-17							
				Pm-151	2.7E-10	1.0E-06						2.7E-16							
				Pt-195m	5.5E-10	1.0E-06						5.5E-16							
				Pu-238	4.2E-09	1.0E-06						4.2E-15							
				Pu-239	2.5E-08	1.0E-06						2.5E-14							
				Pu-240	1.4E-09	1.0E-06						1.4E-15							
				Pu-241	3.3E-08	1.0E-06						3.3E-14							
				Pu-242	2.8E-08	1.0E-06						2.8E-14							
				Ra-223	2.7E-12	1.0E-06						2.7E-18							
				Ra-226	1.3E-12	1.0E-06						1.3E-18							
				Rh-103	9.1E-09	1.0E-06						9.1E-15							
				Ru-106	1.4E-08	1.0E-06						1.4E-14							
				S-35	3.9E-06	1.0E-06						3.9E-12							
				Sb-125	4.4E-12	1.0E-06						4.4E-18							
				Sm-151	8.2E-12	1.0E-06						8.2E-18							
				Sr-90	7.1E-09	1.0E-06						7.1E-15							
				Th-228	7.8E-10	1.0E-06						7.8E-16							
				Th-230	6.8E-10	1.0E-06						6.8E-16							
				Th-232	1.2E-09	1.0E-06						1.2E-15							
				U-233	1.8E-09	1.0E-06						1.8E-15							
				U-234	6.4E-05	1.0E-06						6.4E-11							
				U-235	2.8E-06	1.0E-06						2.8E-12							
				U-237	1.9E-08	1.0E-06						1.9E-14							
				U-238	6.0E-05	1.0E-06						6.0E-11							
				Zr-95	3.4E-08	1.0E-06						3.4E-14							
				MFP	2.1E-08	1.0E-06						2.1E-14							

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	10 mrem/y Site-Wide Dose Requirement: Direction to SWMEI	10 mrem/y Site-Wide Dose Requirement: EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	0.1 mrem/y Monitoring Requirement: Direction to MEI	0.1 mrem/y Monitoring Requirement: Unabated EDE (mrem)	Source Category
612	101	FHE-4	Laboratory analysis of waste treatment and treatability samples	Am-241	5.6E-05	1.0E-03	10.5	0.31	5.4	HEPA	0.01	5.6E-10	444	NE	3.7E-06	384	NE	3.7E-06	1
				Am-243	4.2E-06	1.0E-03						4.2E-11							
				Ba-133	5.0E-06	1.0E-03						5.0E-11							
				Bi-207	2.4E-07	1.0E-03						2.4E-12							
				Bi-210	2.8E-07	1.0E-03						2.8E-12							
				C-14	2.8E-04	1.0E-03						2.8E-09							
				Cd-109	8.4E-10	1.0E-03						8.4E-15							
				Ce-139	2.8E-13	1.0E-03						2.8E-18							
				Ce-144	2.8E-05	1.0E-03						2.8E-10							
				Cf-249	2.8E-07	1.0E-03						2.8E-12							
				Cm-244	3.4E-06	1.0E-03						3.4E-11							
				Co-56	5.6E-08	1.0E-03						5.6E-13							
				Co-57	1.5E-06	1.0E-03						1.5E-11							
				Co-60	8.8E-07	1.0E-03						8.8E-12							
				Cs-134	3.4E-06	1.0E-03						3.4E-11							
				Cs-137	1.4E-04	1.0E-03						1.4E-09							
				Eu-152	1.4E-05	1.0E-03						1.4E-10							
				Eu-154	1.4E-05	1.0E-03						1.4E-10							
				Eu-155	1.0E-06	1.0E-03						1.0E-11							
				Gd-148	3.4E-06	1.0E-03						3.4E-11							
				H-3	7.8E-04	1.0E-03						7.8E-09							
				K-40	1.1E-05	1.0E-03						1.1E-10							
				Mn-54	6.5E-07	1.0E-03						6.5E-12							
				Na-22	8.0E-08	1.0E-03						8.0E-13							
				Nb-95	3.8E-08	1.0E-03						3.8E-13							
				Ni-63	2.8E-08	1.0E-03						2.8E-13							
				Np-237	3.4E-06	1.0E-03						3.4E-11							
				Np-239	6.7E-08	1.0E-03						6.7E-13							
				P-32	1.7E-05	1.0E-03						1.7E-10							
				Pb-210	3.6E-06	1.0E-03						3.6E-11							
				Po-209	2.8E-07	1.0E-03						2.8E-12							
				Po-210	2.8E-07	1.0E-03						2.8E-12							
				Pu-238	3.8E-06	1.0E-03						3.8E-11							
				Pu-239	8.4E-05	1.0E-03						8.4E-10							
				Pu-241	1.0E-05	1.0E-03						1.0E-10							
				Pu-242	9.9E-06	1.0E-03						9.9E-11							
				Pu-244	2.8E-09	1.0E-03						2.8E-14							
				Ra-226	2.9E-07	1.0E-03						2.9E-12							
				Sb-125	1.0E-06	1.0E-03						1.0E-11							
				Sr-90	2.8E-04	1.0E-03						2.8E-09							
				Tc-99	3.4E-06	1.0E-03						3.4E-11							
				Th-228	4.2E-08	1.0E-03						4.2E-13							
				Th-229	3.4E-06	1.0E-03						3.4E-11							
				Th-230	3.4E-06	1.0E-03						3.4E-11							
				Th-232	3.4E-06	1.0E-03						3.4E-11							
				U-232	3.4E-06	1.0E-03						3.4E-11							
				U-233	7.3E-06	1.0E-03						7.3E-11							
				U-234	5.4E-05	1.0E-03						5.4E-10							
				U-235	3.5E-06	1.0E-03						3.5E-11							
				U-238	2.0E-04	1.0E-03						2.0E-09							
				Y-88	1.6E-07	1.0E-03						1.6E-12							
612	102	Room Air	Laboratory analysis of waste treatment and treatability samples	Am-241	5.6E-05	1.0E-03	NA	NA	NA	None	1	5.6E-08	444	NE	6.2E-04	295	ENE	9.4E-04	1
				Am-243	4.2E-06	1.0E-03						4.2E-09							
				Ba-133	5.0E-06	1.0E-03						5.0E-09							
				Bi-207	2.4E-07	1.0E-03						2.4E-10							
				Bi-210	2.8E-07	1.0E-03						2.8E-10							
				C-14	2.8E-04	1.0E-03						2.8E-07							
				Cd-109	8.4E-10	1.0E-03						8.4E-13							
				Ce-139	2.8E-13	1.0E-03						2.8E-16							
				Ce-144	2.8E-05	1.0E-03						2.8E-08							
				Cf-249	2.8E-07	1.0E-03						2.8E-10							
				Cm-244	3.4E-06	1.0E-03						3.4E-09							
				Co-56	5.6E-08	1.0E-03						5.6E-11							
				Co-57	1.5E-06	1.0E-03						1.5E-09							
				Co-60	8.8E-07	1.0E-03						8.8E-10							
				Cs-134	3.4E-06	1.0E-03						3.4E-09							
				Cs-137	1.4E-04	1.0E-03						1.4E-07							
				Eu-152	1.4E-05	1.0E-03						1.4E-08							
				Eu-154	1.4E-05	1.0E-03						1.4E-08							
				Eu-155	1.0E-06	1.0E-03						1.0E-09							
				Gd-148	3.4E-06	1.0E-03						3.4E-09							
				H-3	7.8E-04	1.0E-03						7.8E-07							
				K-40	1.1E-05	1.0E-03						1.1E-08							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
612	102	(continued)		Mn-54	6.5E-07	1.0E-03						6.5E-10							
				Na-22	8.0E-08	1.0E-03						8.0E-11							
				Nb-95	3.8E-08	1.0E-03						3.8E-11							
				Ni-63	2.8E-08	1.0E-03						2.8E-11							
				Np-237	3.4E-06	1.0E-03						3.4E-09							
				Np-239	6.7E-08	1.0E-03						6.7E-11							
				P-32	1.7E-05	1.0E-03						1.7E-08							
				Pb-210	3.6E-06	1.0E-03						3.6E-09							
				Po-209	2.8E-07	1.0E-03						2.8E-10							
				Po-210	2.8E-07	1.0E-03						2.8E-10							
				Pu-238	3.8E-06	1.0E-03						3.8E-09							
				Pu-239	8.4E-05	1.0E-03						8.4E-08							
				Pu-241	1.0E-05	1.0E-03						1.0E-08							
				Pu-242	9.9E-06	1.0E-03						9.9E-09							
				Pu-244	2.8E-09	1.0E-03						2.8E-12							
				Ra-226	2.9E-07	1.0E-03						2.9E-10							
				Sb-125	1.0E-06	1.0E-03						1.0E-09							
				Sr-90	2.8E-04	1.0E-03						2.8E-07							
				Tc-99	3.4E-06	1.0E-03						3.4E-09							
				Th-228	4.2E-08	1.0E-03						4.2E-11							
				Th-229	3.4E-06	1.0E-03						3.4E-09							
				Th-230	3.4E-06	1.0E-03						3.4E-09							
				Th-232	3.4E-06	1.0E-03						3.4E-09							
				U-232	3.4E-06	1.0E-03						3.4E-09							
				U-233	7.3E-06	1.0E-03						7.3E-09							
				U-234	5.4E-05	1.0E-03						5.4E-08							
				U-235	3.5E-06	1.0E-03						3.5E-09							
				U-238	2.0E-04	1.0E-03						2.0E-07							
				Y-88	1.6E-07	1.0E-03						1.6E-10							
Building 625 is operated by Hazardous Waste Management.																			
625	Repack Tent	FHE	Waste inspection and repackaging	H-3	2.5E-08	1.0E-06	1.5	0.31	6.9	HEPA	0.01	2.5E-16	355	NE	1.1E-12	289	ENE	1.1E-10	1
				K-40	2.2E-09	1.0E-06						2.2E-17							
				U-234	7.5E-10	1.0E-06						7.5E-18							
				U-235	2.7E-11	1.0E-06						2.7E-19							
				U-238	6.4E-10	1.0E-06						6.4E-18							
				Ce-144	8.5E-13	1.0E-06						8.5E-21							
				Am-241	2.2E-08	1.0E-06						2.2E-16							
				Cs-137	7.2E-09	1.0E-06						7.2E-17							
				Cm-243	3.4E-11	1.0E-06						3.4E-19							
				Cm-245	4.8E-12	1.0E-06						4.8E-20							
				Ba-133	3.2E-10	1.0E-06						3.2E-18							
				Co-60	3.9E-10	1.0E-06						3.9E-18							
				Pu-238	2.8E-11	1.0E-06						2.8E-19							
				Pu-239	5.6E-11	1.0E-06						5.6E-19							
SITE 300 POINT SOURCES																			
Site 300 - Explosives tests in which radionuclides may be present are conducted on open-air firing tables located at Bunkers 801 and 851. These tests have depleted uranium material as part of the material inventory. There are multiple tests per year.																			
Air activation products are created at the flash x-ray and LINAC.																			
810A	109	Room Air	Assembly of explosives	U-238	5.4E-02	1.0E-06	NA	NA	NA	None	1	5.4E-08	2360	WSW	2.8E-07	944	SSE	6.7E-06	2
	121		test devices	U-235	6.9E-04	1.0E-06						6.9E-10							
	133			U-234	5.0E-03	1.0E-06						5.0E-09							
810B	100	Room Air	Assembly of explosives	U-238	1.6E-02	1.0E-06	NA	NA	NA	None	1	1.6E-08	2410	WSW	7.8E-08	907	SSE	2.1E-06	2
			test devices	U-235	2.0E-04	1.0E-06						2.0E-10							
				U-234	1.5E-03	1.0E-06						1.5E-09							
801	125	FE-4	Flash X-ray (FXR)	N-13	3.4E-03	1.0E+00	NA	NA	NA	None	1	3.4E-03	4114	S	1.8E-08	1809	ENE	3.6E-07	2
				Ar-41	2.0E-07	1.0E+00						2.0E-07							
851	Firing Table	None	Explosive tests	U-238	6.2E-02	1.0E+00	NA	NA	NA	None	1	6.2E-02	3170	SSE	5.0E-02	1396	WSW	5.7E-02	4
				U-235	8.0E-04	1.0E+00						8.0E-04							
				U-234	5.8E-03	1.0E+00						5.8E-03							
851	111	None	Linear accelerator	N-13	8.2E-02	1.0E+00	NA	NA	NA	None	1	8.2E-02	3170	SSE	1.6E-06	3836	ENE	2.1E-06	2
				O-15	7.6E-02	1.0E+00						7.6E-02							
				Ar-41	1.5E-04	1.0E+00						1.5E-04							

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Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
LIVERMORE SITE DIFFUSE SOURCES																			
Building 292 - Diffuse emissions result from tritium-contaminated water which leaked from an underground storage tank. Vegetation in the area transpires water with elevated tritium concentrations.																			
292	Spill Area	None	Evaporation and transpiration	H-3	NA	1	NA	NA	NA	None	1	4.9E-04	1380	ESE	7.2E-08	456	N	1.8E-06	6
																655	W	1.8E-06	
Building 331 - As part of D&D operations, contaminated equipment outside the facility is awaiting transport and storage by Hazardous Waste Management.																			
***The dose from HTO emissions calculated using the NEWTRIT model; see discussion on page pp. 30-31.																			
331	Outside	None	Storage of contaminated parts	H-3	NA	1	NA	NA	NA	None	1	1.0E+00	957	ENE	8.0E-04	441	SSW	2.2E-03	6
															***6.0E-04			***1.6E-02	
Building 514 is operated by the Hazardous Waste Management Division. The wastewater treatment tank farm and storage tank area processes the liquid waste from facilities on site. The treatment process may involve batch chemical treatment																			
consisting of neutralization, flocculation, oxidation, reduction, precipitation, separation, and filtration. Areas used for storage are not considered to release radionuclides because the wastes are fully contained.																			
514	Tank Farm	Area Source	Process liquid hazardous	Am-241	1.5E-04	1.0E-03	NA	NA	NA	None	1	1.5E-07	528	NE	1.3E-03	217	SW	3.0E-03	5
			mixed and radioactive wastes in	Am-243	1.2E-05	1.0E-03						1.2E-08							
			open topped tanks.	Ba-133	1.4E-05	1.0E-03						1.4E-08							
				Bi-207	6.5E-07	1.0E-03						6.5E-10							
				Bi-210	7.6E-07	1.0E-03						7.6E-10							
				C-14	7.6E-04	1.0E-03						7.6E-07							
				Cd-109	2.3E-09	1.0E-03						2.3E-12							
				Ce-139	7.6E-13	1.0E-03						7.6E-16							
				Ce-144	7.6E-05	1.0E-03						7.6E-08							
				Cf-249	7.6E-07	1.0E-03						7.6E-10							
				Cm-244	9.1E-06	1.0E-03						9.1E-09							
				Co-56	1.5E-07	1.0E-03						1.5E-10							
				Co-57	4.1E-06	1.0E-03						4.1E-09							
				Co-60	2.4E-06	1.0E-03						2.4E-09							
				Cs-134	9.1E-06	1.0E-03						9.1E-09							
				Cs-137	3.8E-04	1.0E-03						3.8E-07							
				Eu-152	3.7E-05	1.0E-03						3.7E-08							
				Eu-154	3.7E-05	1.0E-03						3.7E-08							
				Eu-155	2.8E-06	1.0E-03						2.8E-09							
				Gd-148	9.1E-06	1.0E-03						9.1E-09							
				H-3	2.1E-03	1.0E-03						2.1E-06							
				K-40	3.0E-05	1.0E-03						3.0E-08							
				Mn-54	1.8E-06	1.0E-03						1.8E-09							
				Na-22	2.2E-07	1.0E-03						2.2E-10							
				Nb-95	1.0E-07	1.0E-03						1.0E-10							
				Ni-63	7.6E-08	1.0E-03						7.6E-11							
				Np-237	9.1E-06	1.0E-03						9.1E-09							
				Np-239	1.8E-07	1.0E-03						1.8E-10							
				P-32	4.6E-05	1.0E-03						4.6E-08							
				Pb-210	9.9E-06	1.0E-03						9.9E-09							
				Po-209	7.6E-07	1.0E-03						7.6E-10							
				Po-210	7.6E-07	1.0E-03						7.6E-10							
				Pu-238	1.0E-05	1.0E-03						1.0E-08							
				Pu-239	2.3E-04	1.0E-03						2.3E-07							
				Pu-241	2.7E-05	1.0E-03						2.7E-08							
				Pu-242	2.7E-05	1.0E-03						2.7E-08							
				Pu-244	7.6E-09	1.0E-03						7.6E-12							
				Ra-226	7.8E-07	1.0E-03						7.8E-10							
				Sb-125	2.8E-06	1.0E-03						2.8E-09							
				Sr-90	7.6E-04	1.0E-03						7.6E-07							
				Tc-99	9.2E-06	1.0E-03						9.2E-09							
				Th-228	1.1E-07	1.0E-03						1.1E-10							
				Th-229	9.1E-06	1.0E-03						9.1E-09							
				Th-230	9.1E-06	1.0E-03						9.1E-09							
				Th-232	9.1E-06	1.0E-03						9.1E-09							
				U-232	9.1E-06	1.0E-03						9.1E-09							
				U-233	2.0E-05	1.0E-03						2.0E-08							
				U-234	1.5E-04	1.0E-03						1.5E-07							
				U-235	9.5E-06	1.0E-03						9.5E-09							
				U-238	5.3E-04	1.0E-03						5.3E-07							
				Y-88	4.4E-07	1.0E-03						4.4E-10							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement			0.1 mrem/y Monitoring Requirement			Source Category
													Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	
The Building 612 Yard is operated by the Hazardous Waste Management Division. The Yard consists of several areas where containers having radioactive wastes are stacked outdoors. The containers, which are not air tight, can outgas tritium.																			
*The drum sampling operation takes place at all site Waste Accumulation Areas. Inventories were combined and modeled as if the operation occurred at the center of the site.																			
***The dose from HTO emissions estimate calculated using the NEWTRIT model is 1.1e-02. See discussion on page 30.																			
612	Yard	Area Source	Storage of low level waste	H-3	NA	NA	NA	NA	NA	None	1	2.0E+00	444	NNE	8.2E-03	212	SSW	1.6E-02	6
														***6.2E-03					
612	All WAAs*	Area source	Drum sampling in	Am-241	4.1E-10	1.0E-03	NA	NA	NA	None	1	4.1E-13	951	ESE	8.5E-09	969	W	5.1E-08	5
			612 yard and all LLNL Waste	Am-243	1.5E-11	1.0E-03						1.5E-14							
			Accumulation Areas (WAAs)	Bi-207	8.5E-13	1.0E-03						8.5E-16							
				C-14	1.2E-09	1.0E-03						1.2E-12							
				Ce-144	1.2E-10	1.0E-03						1.2E-13							
				Co-57	2.4E-12	1.0E-03						2.4E-15							
				Co-60	6.8E-12	1.0E-03						6.8E-15							
				Cs-134	4.8E-11	1.0E-03						4.8E-14							
				Cs-137	3.0E-10	1.0E-03						3.0E-13							
				Eu-152	4.9E-11	1.0E-03						4.9E-14							
				Eu-154	4.9E-11	1.0E-03						4.9E-14							
				Eu-155	3.6E-12	1.0E-03						3.6E-15							
				H-3	1.0E-05	1.0E-03						1.0E-08							
				K-40	3.3E-11	1.0E-03						3.3E-14							
				Mn-54	2.3E-12	1.0E-03						2.3E-15							
				Nb-95	1.2E-12	1.0E-03						1.2E-15							
				Ni-63	9.5E-11	1.0E-03						9.5E-14							
				Np-239	2.5E-12	1.0E-03						2.5E-15							
				P-32	7.4E-07	1.0E-03						7.4E-10							
				Pu-238	1.1E-12	1.0E-03						1.1E-15							
				Pu-239	1.4E-10	1.0E-03						1.4E-13							
				Pu-240	9.5E-12	1.0E-03						9.5E-15							
				Pu-241	3.1E-10	1.0E-03						3.1E-13							
				Pu-242	4.8E-11	1.0E-03						4.8E-14							
				Ra-226	1.1E-12	1.0E-03						1.1E-15							
				Sb-125	3.6E-12	1.0E-03						3.6E-15							
				Sr-90	1.4E-13	1.0E-03						1.4E-16							
				Tc-99	1.1E-11	1.0E-03						1.1E-14							
				Th-228	6.5E-12	1.0E-03						6.5E-15							
				Th-230	5.5E-14	1.0E-03						5.5E-17							
				Th-232	1.0E-12	1.0E-03						1.0E-15							
				U-234	1.7E-08	1.0E-03						1.7E-11							
				U-235	2.3E-09	1.0E-03						2.3E-12							
				U-238	1.7E-07	1.0E-03						1.7E-10							
612	Yard	Area Source	Repackaging operation	Am-241	4.3E-09	1.0E-06	NA	NA	NA	None	1	4.3E-15	444	NNE	1.0E-09	212	SSW	2.0E-09	5
				Am-242	2.6E-11	1.0E-06						2.6E-17							
				Am-243	7.4E-09	1.0E-06						7.4E-15							
				C-14	9.1E-11	1.0E-06						9.1E-17							
				Ce-144	9.1E-11	1.0E-06						9.1E-17							
				Co-60	2.1E-09	1.0E-06						2.1E-15							
				Cs-137	1.1E-09	1.0E-06						1.1E-15							
				Eu-152	1.0E-08	1.0E-06						1.0E-14							
				Eu-154	5.2E-09	1.0E-06						5.2E-15							
				Eu-155	9.7E-11	1.0E-06						9.7E-17							
				H-3	6.7E-05	1.0E-06						6.7E-11							
				K-40	1.4E-10	1.0E-06						1.4E-16							
				Np-237	8.9E-10	1.0E-06						8.9E-16							
				Pm-147	3.2E-11	1.0E-06						3.2E-17							
				Pu-238	4.0E-10	1.0E-06						4.0E-16							
				Ra-226	1.9E-10	1.0E-06						1.9E-16							
				Ra-228	2.3E-10	1.0E-06						2.3E-16							
				Sb-125	5.9E-11	1.0E-06						5.9E-17							
				Sm-151	9.9E-12	1.0E-06						9.9E-18							
				Sr-90	1.8E-10	1.0E-06						1.8E-16							
				Th-228	1.0E-09	1.0E-06						1.0E-15							
				U-234	1.2E-07	1.0E-06						1.2E-13							
				U-235	1.6E-08	1.0E-06						1.6E-14							
				U-238	1.3E-06	1.0E-06						1.3E-12							
614	Open Area	Area source	Repackaging of waste	H-3	4.7E-03	1.0E-03	NA	NA	NA	None	1	4.7E-06	420	NNE	2.9E-07	253	ENE	6.5E-07	5
			liquid scintillation cocktail	C-14	1.1E-05	1.0E-03						1.1E-08							
				S-35	2.3E-07	1.0E-03						2.3E-10							
				Se-75	2.3E-07	1.0E-03						2.3E-10							
				Th-232	9.1E-09	1.0E-03						9.1E-12							
				U-233	4.6E-09	1.0E-03						4.6E-12							
				Pu-238	2.2E-08	1.0E-03						2.2E-11							

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to SWMEI (m)	Direction to SWMEI	EDE (mrem)	0.1 mrem/y Monitoring Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category
614	Open Area	(continued)		Pu-239	1.8E-12	1.0E-03						1.8E-15							
				Pu-240	1.8E-10	1.0E-03						1.8E-13							
				Pu-241	4.1E-08	1.0E-03						4.1E-11							
				Pu-242	9.5E-08	1.0E-03						9.5E-11							
				U-234	2.3E-09	1.0E-03						2.3E-12							
				U-235	1.0E-10	1.0E-03						1.0E-13							
				U-238	2.2E-09	1.0E-03						2.2E-12							
The Southeast Quadrant of the Livermore Site has slightly elevated levels of Pu-239 in the surface soil and air (presumably from resuspension). The source of the Pu-239 was past waste management operations.																			
Southeast Quadrant		Area Source	Resuspension	Pu-239	NA	NA	NA	NA	NA	None	1	NA	0	NA	8.8E-04	NA	NA	NA	6
SITE 300 DIFFUSE SOURCES																			
Diffuse sources consist of resuspension of depleted uranium and waste handling.																			
Site 300	All	Area Source	Soil resuspension	U-238	NA	NA	NA	NA	NA	None	1	NA	NA	NA	3.7E-03	NA	NA	NA	6
				U-235	NA	NA						NA							
				U-234	NA	NA						NA							
804	Open Area	Area Source	Low-level waste staging area	H-3	NA	NA	NA	NA	NA	None	1	3.9E-04	4508	S	2.1E-07	828	N	4.5E-06	6
				U-238	NA	NA						5.1E-08							
				U-235	NA	NA						6.5E-10							
				U-234	NA	NA						3.1E-09							
EMISSION SOURCES THAT ACCOUNT FOR MORE THAN 90% OF THE POTENTIAL EFFECTIVE DOSE EQUIVALENT AT EACH SITE.																			
LIVERMORE SITE SOURCES																			
612	Yard	Area Source	Storage of low level waste	H-3	NA	NA	NA	NA	NA	None	1	2.0E+00	444	NNE	8.2E-03	212	SSW	1.6E-02	6
331	All**	Stack 1	Tritium research and development	H-3	*	1	30	1.22	7.59	None	1	2.7E+00	957	ENE	4.3E-03	957	ENE	4.3E-03	3
		Stack 2	Decontamination of parts	H-3	*	1	30	1.22	10.5	None	1	1.7E+01			3.1E-03 ***			3.1E-03 ***	
514	Tank Farm	Area Source	Process liquid hazardous	Various nuclides	1.5E-04	0.001	NA	NA	NA	None	1	1.52E-07	528	NE	1.3E-03	217	SW	3.0E-03	5
Southeast Quadrant		Area Source	Resuspension	Pu-239	NA	NA	NA	NA	NA	None	1	NA	0	NA	8.8E-04	NA	NA	NA	6
612	102	Room Air	Laboratory analysis	Various nuclides	5.6E-05	0.001	NA	NA	NA	None	1	5.6E-08	444	NE	6.2E-04	295	ENE	9.4E-04	1
514	Evaporator	Room Air	Waste consolidation	Various nuclides	0.0001	0.001	NA	NA	NA	None	1	1.0E-07	528	NE	5.8E-04	217	SW	1.2E-03	1
SITE 300 SOURCES																			
851	Firing Table	None	Explosive tests	U-238	6.2E-02	1	NA	NA	NA	None	1	6.2E-02	3170	SSE	5.0E-02	1396	WSW	5.7E-02	4
				U-235	8.0E-04	1						3.1E-04							
				U-234	5.8E-03	1						2.3E-03							
Site 300	All	Area Source	Soil resuspension	U-238	NA	NA	NA	NA	NA	None	1	NA	NA	NA	3.7E-03	NA	NA	NA	6
				U-235	NA	NA						NA							
				U-234	NA	NA						NA							

ATTACHMENT 2. Surrogate Radionuclides List

The need for selection of a surrogate isotope occurs when an isotope used in operations (isotope of interest) is not contained in the limited nuclide library in the NESHAPs dose compliance model CAP88-PC. The selection of a suitable surrogate is based upon several criteria. If possible, a surrogate isotope is chosen from the CAP88-PC radionuclide library that has a metabolically similar behavior to the isotope of interest. Following an acute inhalation exposure, the metabolically similar surrogate would concentrate in the same specific organs and tissues as the isotope of interest. In most cases the surrogate selected possesses similar modes of decay and decay energies of the radiation type of the isotope of interest. Thus, the surrogate models the behavior of the isotope with similar relative biological effect due to deposition energy.

According to present knowledge, the daughter nuclides produced following physical decay are assumed to remain organ site specific and follow the translocation pathway of the parent. Therefore, when a surrogate of similar metabolic behavior is not available or has a greatly dissimilar half-life, the surrogate chosen is a daughter nuclide of the isotope of interest that will remain organ site specific and follow the translocation pathway of the parent.

Once a surrogate has been selected, the equivalent source term is adjusted by the product of the initial inventory of the isotope of interest and the ratio of the effective dose equivalent of the surrogate to that of the isotope of interest. For determining the dose ratio, the primary exposure pathway is assumed to be that of inhalation and inhalation dose conversion factors (International Commission on Radiological Protection Publication No. 71, "Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients," Elsevier Science Ltd., 1996) are used for determination of the effective dose equivalents.

In addition, isotopic analysis of mixtures of radionuclides are not always available, and radionuclide usage inventories are stated as "gross alpha," "gross beta," "gross gamma," or "mixed fission products" (MFP). In these cases, ^{239}Pu is used as the surrogate for gross alpha, ^{137}Cs is used as the surrogate for gross gamma, and ^{90}Sr is used as the surrogate for gross beta and mixed fission products to provide conservative dose estimates.

Table 2-1 provides a list of radionuclides not in the CAP88-PC library and their respective surrogates.

Table 2-1. List of surrogate radionuclides.

Isotope	Half-Life	Lung Class[a]	ALI (inh) μCi	DAC (inh) μCi/m^3	Surrogate	Half-Life	Lung Class[a]	ALI (inh) μCi	DAC (inh) μCi/m^3
Ca-108m	127 y	Y	2.0×10^{1}	1.0×10^{-8}	**Co-60**	5.271 y	Y	3.0×10^{1}	1.0×10^{-8}
Bi-207	38 y	W	4.0×10^{2}	1.0×10^{-7}	**Bi-214**	19.9 min	W	9.0×10^{2}	4.0×10^{-7}
Ca-45	163 d	W	8.0×10^{2}	4.0×10^{-7}	**Sr-90**	29.12 y	D	2.0×10^{1}	8.0×10^{-9}
Cd-109	464 d	Y	1.0×10^{2}	5.0×10^{-8}	**Co-60**	5.271 y	Y	3.0×10^{1}	1.0×10^{-8}
Cf-249	350.6 y	Y	1.0×10^{-2}	4.0×10^{-12}	**Cm-245**	8500 y	W	6.0×10^{-3}	3.0×10^{-12}
Cf-250	13.1 y	W	9.0×10^{-3}	4.0×10^{-12}	**Am-241**	432.2 y	W	6.0×10^{-3}	3.0×10^{-12}
Cl-36	3.01×10^{5} y	W	2.0×10^{2}	1.0×10^{-7}	**Cs-137**	30 y	D	2.0×10^{2}	6.0×10^{-8}
Es-254	275.7 d	W	7.0×10^{-2}	3.0×10^{-11}	**Pu-239**	24065 y	Y	2.0×10^{-2}	7.0×10^{-12}
Eu-149	93.1 d	W	3.0×10^{3}	1.0×10^{-6}	**Pm-151**	28.4 hr	Y	3.0×10^{3}	1.0×10^{-6}
Gd-148	93 y	D	8.0×10^{-3}	3.0×10^{-12}	**La-140**	40.272 h	W	1.0×10^{3}	5.0×10^{-7}
Os-185	94 d	D	5.0×10^{2}	2.0×10^{-7}	**Mo-99**	66 h	Y	1.0×10^{3}	6.0×10^{-7}
P-33	25.4 d	W	3.0×10^{3}	1.0×10^{-6}	**P-32**	14.29 d	D	9.0×10^{2}	4.0×10^{-7}
Re-184	38 d	W	1.0×10^{3}	6.0×10^{-7}	**Mo-99**	66 h	Y	1.0×10^{3}	6.0×10^{-7}
Se-75	119.8 d	W	6.0×10^{2}	3.0×10^{-7}	**As-76**	26.32 h	W	1.0×10^{3}	6.0×10^{-7}
Sr-85	64.8 d	D	3.0×10^{3}	1.0×10^{-6}	**Sr-90**	29.12 y	D	2.0×10^{1}	8.0×10^{-9}
Ta-182	115 d	Y	1.0×10^{2}	6.0×10^{-8}	**Hf-181**	42.4 d	W	4.0×10^{2}	2.0×10^{-7}
Tb-157	110 y	W	3.0×10^{2}	1.0×10^{-7}	**La-140**	40.272 h	W	1.0×10^{3}	5.0×10^{-7}
Tb-158	180 y	W	2.0×10^{1}	8.0×10^{-9}	**La-140**	40.272 h	W	1.0×10^{3}	5.0×10^{-7}
Tl-204	3.78 y	D	2.0×10^{3}	9.0×10^{-7}	**Pb-214**	26.8 min	D	8.0×10^{2}	3.0×10^{-7}
Tm-168	93.1 d	W	2.0×10^{3}	8.0×10^{-7}	**La-140**	40.272 h	W	1.0×10^{3}	5.0×10^{-7}
Tm-171	1.92 y	Y	3.0×10^{2}	1.0×10^{-7}	**La-140**	40.272 h	W	1.0×10^{3}	5.0×10^{-7}
Y-88	106.64 d	Y	2.0×10^{2}	1.0×10^{-7}	**Y-90**	64 h	Y	6.0×10^{2}	3.0×10^{-7}
Am-244	10.1 h	W	2.0×10^{2}	8.0×10^{-8}	**Cm-244**	18.11 y	W	1.0×10^{-2}	5.0×10^{-12}
Au-195	183 d	Y	4.0×10^{2}	2.0×10^{-7}	**Ba-133**	10.74 y	D	7.0×10^{2}	3.0×10^{-7}
Co-56	78.76 d	Y	2.0×10^{2}	8.0×10^{-8}	**Co-60**	5.271 y	Y	3.0×10^{1}	1.0×10^{-8}
Gd-146	48.3 d	W	3.0×10^{2}	1.0×10^{-7}	**Sm-147**	1.06×10^{11} y	W	4.0×10^{-2}	2.0×10^{-11}
Kr-85	10.72 y	Gas	See Note	1.0×10^{-4}					
Rh-102	2.9 y	Y	6.0×10^{1}	2.0×10^{-8}	**Rh-106m**	29.9 s	Y	4.0×10^{4}	1.0×10^{-5}
U-239	23.54 min	Y	2.0×10^{5}	6.0×10^{-5}	**U-240**	14.1 h	Y	2.0×10^{3}	1.0×10^{-6}
Zr-90	809 ms	W	N/A	N/A	**Y-90**	64 h	Y	6.0×10^{2}	3.0×10^{-7}
Po-209 [b]	102 y	N/A	N/A	N/A	**Pu-239**	24065 y	Y	2.0×10^{-2}	7.0×10^{-12}

Note: The DAC for Kr-85 also has been relaxed considerably since its beta emission only irradiates the skin. The DAC is based on limitation of non-stochastic effects in the skin; the MPC was derived assuming that the beta particles of energy greater than 0.1 MeV contributed to the whole body dose.

a D = days, W = weeks, Y = years.

b No ALI or DAC information available. Pu-239 used to provide a conservative alpha-emitter dose.

Source: Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion, Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. Environmental Protection Agency, 1988.

ATTACHMENT 3. Content and Outcome of Proposal to EPA for Use of a Graded-Risk Approach for NESHAPs Compliance

Lawrence Livermore National Laboratory
ENVIRONMENTAL PROTECTION DEPARTMENT
Operations and Regulatory Affairs Division

July 12, 2001

Jack Broadbent, Director
Air Division
U.S. Environmental Protection Agency, Region IX
75 Hawthorne St.
San Francisco, CA 94105

Subject: Graded Approach to Compliance Demonstration for Radionuclide NESHAPs

By a letter dated February 9, 2001, Lawrence Livermore National Laboratory (LLNL) personnel suggested the possibility of changing our graded approach to compliance demonstration for radionuclide NESHAPs (40 CFR 61, Subpart H). Shortly thereafter, U.S. EPA Region IX staff, by telephone, asked for additional information about our suggested change. This letter is provided in an effort to explain and support our February 9 request.

Our current practice to demonstrate compliance is to provide an annual accounting for stack-monitored sources, explosive test dispersion, surveillance-monitored diffuse sources, new inventoried sources, and previously inventoried sources that contribute to 90% of the dose (when ordered by largest contributors), and to provide a complete accounting of all sources, no matter how small or insignificant, every three years.

Our proposed compliance demonstration would not affect our annual evaluation and reporting of stack monitored sources, explosive test dispersion, or surveillance monitored diffuse sources. Only the treatment of inventoried sources would be modified. (Inventoried sources are those for which the emissions estimates are based on Appendix D to Part 61—Methods for Estimating Radionuclide Emissions.) We would like to establish a risk-based graded approach where inventoried sources with a lifetime risk level of greater than 1×10^{-10} would be evaluated every year (about 20—25 sources) and the dose consequences reported in the annual report. Those sources with a lesser risk/dose would be evaluated before startup and whenever there are changes in operations, with the dose consequences documented to internally maintained files. (A risk of 1×10^{-10} is equivalent to 0.000005 mrem, based on the EPA risk factor of 2×10^{-4} per 10 mrem exposure, as stated in the radionuclide NESHAPs Final Rule promulgation 54 Fed. Reg. 51654, *et seq.*)

The value 1×10^{-10} risk as a point for determination of significance was chosen because it is three orders of magnitude below the "negligible individual dose level" of 1×10^{-7} (annual risk commitment increment) suggested by the National Council on Radiological Protection and Measurements (NCRP) as the lower limit for the application of ALARA

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(NCRP Report #91; Recommendations on Limits for Exposure to Ionizing Radiation, 1987). The NCRP describes the NIRL in the following manner:

> A negligible individual risk level (NIRL) is defined here as a level of average annual excess risk of fatal health effects attributable to irradiation, below which further effort to reduce radiation exposure to the individual is unwarranted. The NIRL is regarded as *trivial* [emphasis in original] compared to the risk of fatality associated with ordinary, normal societal activities and can, therefore, be *dismissed from consideration* [emphasis in original].
> ...
> In the radiation protection field, the need for a reasonably negligible risk level to avoid excessive control actions and expenditures to reduce individual risk has long been recognized. In effect, regulatory practices have involved low exposure cut-off levels for various hazardous agents or situations, apparently on the basis of the triviality of the risks as compared with other natural or man-made risks. Decisions based on the concept of reasonably negligible risk are made frequently in many societal and individual activities.

We selected a value three-orders of magnitude (1 one-thousandth) of the NIRL to assure an adequate margin for reporting because LLNL has, and most likely will continue to have, more than 100 inventoried sources contributing very small doses (and, therefore, risks). The choice of a value three-orders of magnitude below the NIRL assures that the sum of these small sources will not exceed the NIRL.

Interestingly, the concept of risk is one that directly involves populations. A risk of 1×10^{-7} means that one person in 10 million is at risk of fatality. Similarly, a risk of 1×10^{-10} means that one person in 10 billion is at risk of fatality. The choice of such a low risk level as a screening level is protective of all people who could possibly be exposed.

In implementing this risk-based graded approach, we would continue to evaluate all sources for their dose consequences. However, those sources having risk levels less than 1×10^{-10} would be documented internally, and would not be part of the formal annual NESHAPs report.

The differences between the current graded approach and the suggested risk-based graded approach as applied to LLNL operations in calendar year 2000 are presented in Table 1 (see next page). As can be seen from the table, the differences are in the treatment of low-risk inventoried point sources. If the modified approach had been implemented in calendar year 2000, 122 sources would have been documented internally. The frequency distribution of sources by dose for calendar year 2000 is typical of the data since reporting began. Among the inventoried sources having low associated risks are radiological measurement laboratories where the radioactivity of environmental or bioassay samples is measured; metallography laboratories where small metallic uranium samples are prepared and analyzed for physical structure; and research facilities where radiolabeled DNA and other compounds are used.

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Table 1. Comparison of graded approaches by emission category for calendar year 2000.

	Current graded approach				Proposed graded approach			
Emission category	Frequency of evaluation	Dose level (mrem)	Risk level	Number of sources	Frequency of evaluation	Dose level (mrem)	Risk level	Number of sources
Monitored stack emissions	Annual	Any	Any	46	Same	Same	Same	Same
Site 300 Shots	Annual	Any	Any	1	Same	Same	Same	Same
Monitored diffuse sources	Annual	Annual	Annual	4	Same	Same	Same	Same
Inventoried stack emissions, room air, diffuse sources	Annual	Approx. 0.001 (New sources and top 90% contributors to dose)	Approx. $\geq 2 \times 10^{-8}$	5	Same	$\geq 5 \times 10^{-6}$	$\geq 1 \times 10^{-10}$	18
Inventoried stack emissions, room air, diffuse sources	Triennial update	Approx. <0.001	Approx. $< 2 \times 10^{-8}$	135	Pre-operational (NEPA/IWS) review as operations are proposed or changed (to be documented internally)	$> 5 \times 10^{-6}$	$< 1 \times 10^{-10}$	122

We believe this administrative change from our current practice is justifiable based on nearly ten years of reporting data for very small sources. In addition, LLNL has made an institutional commitment to Integrated Safety Management, which has added another venue for surfacing NESHAPs Subpart H issues in planned and existing projects.

The requested reporting method is also consistent with other radionuclide NESHAPs regulations. Facilities having radionuclide emissions, but regulated by 40 CFR 61, Subpart I, are exempt from reporting requirements if the dose consequences are less than 10% of the 10 mrem standard (i.e., less than 1 mrem); they must, however, keep internal records of the determination of dose. The total LLNL dose consequences are now less than 1% of the standard, and the sources that would not be reported, but documented internally, under the new graded approach represent doses less than 0.01% of the standard.

Finally, we believe this proposed change is consistent with the U.S. EPA's position taken with respect to reporting exemptions for releases of naturally occurring radionuclides

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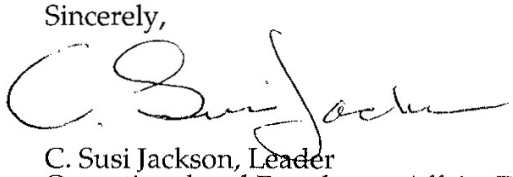
from coal and coal ash piles. In that regard, the U.S. EPA has stated "Eliminating needless reporting burdens . . . will also allow EPA to better focus its resources on the most serious releases, resulting in more effective protection of public health and welfare and the environment." (63 Fed. Reg. 13460, March 19, 1998.)

The new graded approach would have the added benefit of making the annual LLNL NESHAPs report more understandable to the public, because the report would be focused on the most significant sources of emissions.

To summarize, we are requesting implementation of a risk-based graded approach the effect of which would be to evaluate the doses from inventoried sources having a risk of less than 1×10^{-10} once and document the evaluation internally only; such evaluations would be conducted whenever a new activity is proposed or an existing activity changed. All other evaluation and reporting practices would remain the same. We hope this letter clarifies our request for a change in the graded approach to radionuclide NESHAPs compliance demonstration. Please contact Art Biermann (925) 422-8017 with any questions. Thank you for your continued attention to our requests.

Sincerely,



C. Susi Jackson, Leader
Operational and Regulatory Affairs Division

CSJ/GG/jk
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Subject: Response to Letter of July 12, 2001 Requesting Implementation of a Risk-based Graded Approach

Dear Ms. Jackson:

This letter is in response to your letter of July 12, 2001 (enclosed), which provided additional explanation and support for Lawrence Livermore National Laboratory's (LLNL) request of February 9, 2001, that LLNL be permitted to change the current graded approach for demonstrating compliance with EPA's radionuclide NESHAPs at 40 C.F.R. Part 61, Subpart H. We have reviewed the data and information contained in your July 12 letter, and, while we agree that LLNL has presented a scientifically credible rationale, we have concluded that at the present time, the specific regulatory requirements of 40 C.F.R. Part 61, Subpart H for compliance demonstration do not allow the type of graded approach that LLNL requests. Accordingly, we must disapprove your request, at this time.

If you have any questions regarding this disapproval, or if we can be of further assistance, please contact Dick Lessler, at (415) 947-4197.

Sincerely,

Jack P. Broadbent
Director, Air Division

Enclosure

cc: Art Biermann, LLNL

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